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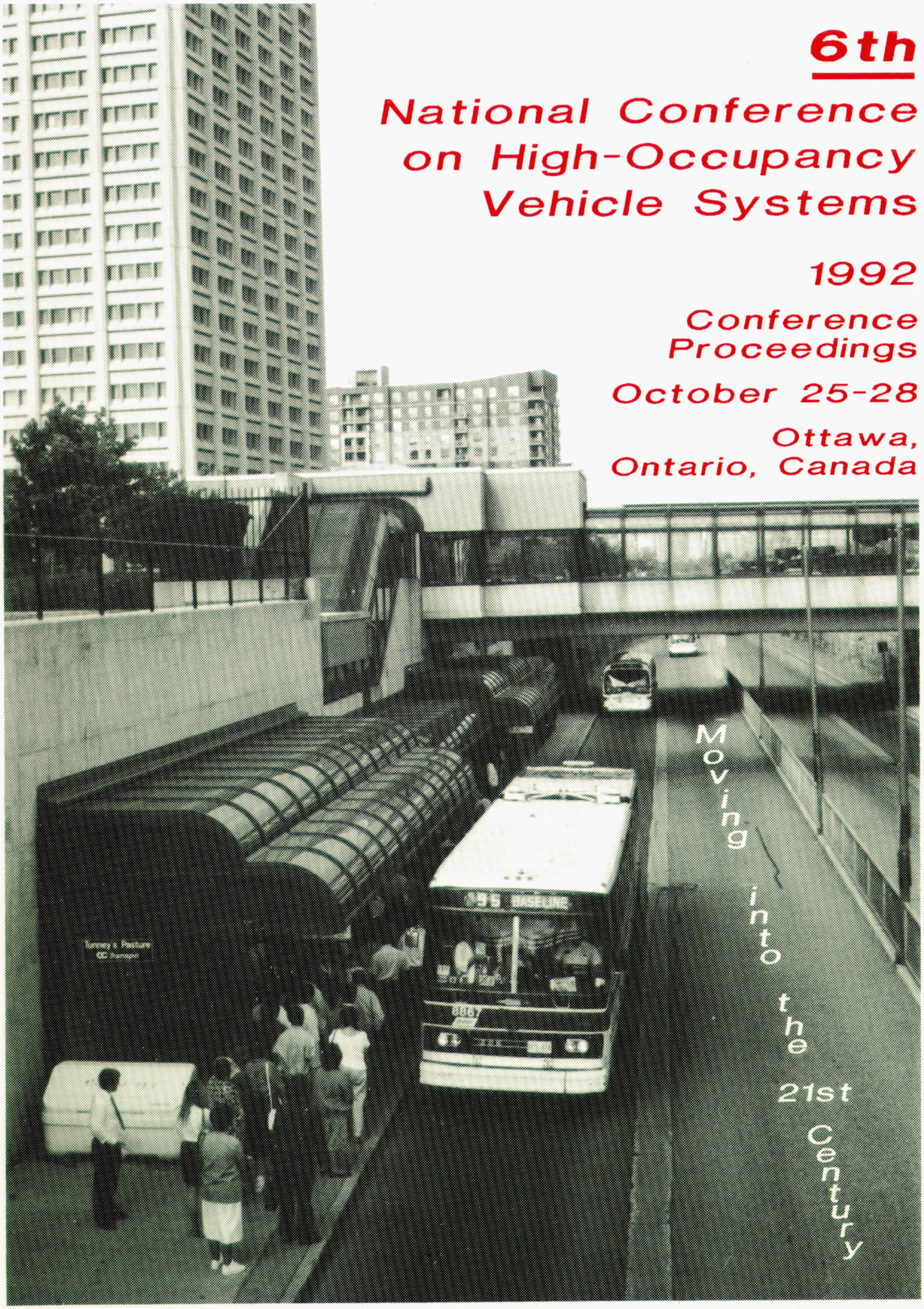
October 25-28

Ottawa, Ontario, Canada



Moving into the 21st Century

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Sixth National Conference on High-Occupancy Vehicle Systems
Moving into the 21st Century

October 25–28, 1992
Château Laurier Hotel
Ottawa, Ontario, Canada

Presented By

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In Cooperation With

Federal Highway Administration
and
Federal Transit Administration

Conference Proceedings

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Sixth National Conference on High-Occupancy Vehicle Systems
Moving into the 21st Century

Conference Hosts

Ottawa-Carleton Regional Transit Commission

and

Ontario Ministry of Transportation

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Sixth National Conference on High-Occupancy Vehicle Systems
Moving into the 21st Century

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These proceedings summarize the highlights from the Sixth National Conference on High-Occupancy Vehicle Systems, which was held this past fall in Ottawa Ontario. The conference brought together transportation professionals from both the United States and Canada. An international perspective was also provided by participants from Spain, Taiwan, and Saudi Arabia.

The conference theme–*Moving into the 21st Century*–provided the overall focus for the keynote speeches, general sessions, and workshops. A wealth of information was presented and discussed on new HOV projects, bus operating strategies, support facilities, HOV policies, air quality issues, arterial street HOV applications, IVHS and HOV facilities, and international HOV projects. Participants were also provided the opportunity to tour the Ottawa Transitway and to learn more about HOV projects in other Canadian cities.

The success of the 1992 HOV conference is the result of hard work by a number of people. John Bonsall and the local planning group did an outstanding job of organizing the local tours and activities. Katie Turnbull and other members of the HOV Systems Committee developed an excellent technical program. Rich Cunard and the Transportation Research Board (TRB) staff did a great job with the arrangements and registration. The TRB, the Ottawa–Carleton Regional Transit Commission, and the Ontario Ministry of Transportation deserve credit for their sponsorship of the conference, in cooperation with the Federal Highway Administration and the Federal Transit Administration.

In addition to sponsoring conferences, the TRB HOV Systems Committee is involved in numerous other activities. The committee is currently developing and pursuing a rigorous research agenda that examines key issues of concern. In addition, the committee will be publishing an HOV glossary, expanding its international outreach program, and examining further coordination with other professional groups. Also, the committee will continue to publish an HOV newsletter and sponsor technical sessions at the TRB Annual Meetings. All these activities are being guided by the recently updated Strategic Plan.

The next HOV conference is scheduled for the spring of 1994 and will be held in Los Angeles. I encourage you to plan now to attend this meeting, which will highlight HOV projects and other transportation related activities in Southern California. The TRB HOV Systems Committee is committed to providing continued leadership in identifying creative and innovative solutions to today's transportation problems. I hope you will become involved in working with the committee to help achieve that goal.

Sincerely,

Donald G. Capelle
Chairman
HOV Systems Committee

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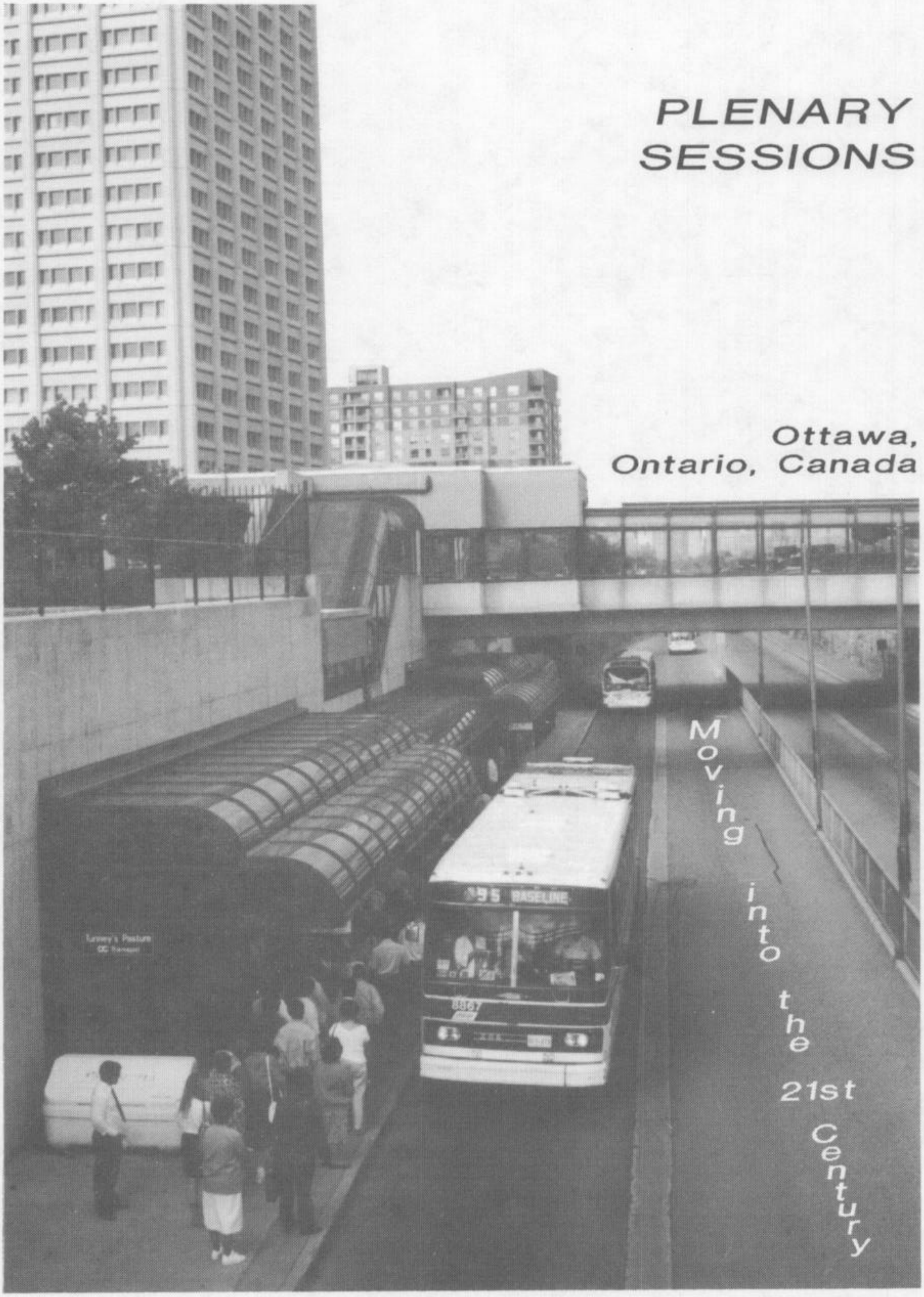
PLENARY SESSIONS

Ottawa, Ontario, Canada

Moving into the 21st Century



Opening Session

John A. Bonsall, Ottawa-Carleton Regional Transit Commission — presiding

Conference Introduction

John A. Bonsall
Ottawa-Carleton Regional Transit Commission

It is a pleasure to welcome you to Ottawa and the Sixth National Conference on High-Occupancy Vehicle Systems. As with previous HOV conferences, we have a multitude of sessions covering different aspects of HOV facilities on the program. What is slightly different about the conference this year is the emphasis on that ultimate high-occupancy vehicle—the bus. We are very proud of the system of exclusive busways here in Ottawa and we are pleased to have the opportunity to host the conference. You will have the chance to see the different facilities during the tour tomorrow. I would also like to encourage each of you to use the bus pass included in your conference registration package for riding the system when you have some extra time.

I also want to invite you to attend the opening of the first freeway bus-only lane in Ontario on Wednesday morning. This facility is a shoulder bus lane on Highway 17 and the grand opening will take place this Wednesday morning. A bus will depart from the hotel to take you to the ceremony and will return in time for the final conference sessions.

I would like to thank a number of people for their help in organizing the conference. First, Rich Cunard and the TRB staff did an excellent job making all the necessary arrangements with the hotel. Second, I would like to thank Katie Turnbull for her assistance in organizing the technical program for the conference. Finally, I would like to recognize my staff for their help in setting up the local tours. I hope all of you will enjoy the conference and the Ottawa area.

Conference Welcome

Peter Clark
Ottawa-Carleton Regional Transit Commission
Regional Municipality of Ottawa-Carleton

Welcome to Ottawa, the capital city of Ontario. As Chairman of the Ottawa-Carleton Regional Transit Commission, it is a pleasure to have the opportunity to welcome you to the Sixth National Conference on HOV Systems and to Ottawa. We are pleased to be hosting the conference and to have you see the Transitway system here in Ottawa.

The Ottawa-Carleton area has a population of approximately 700,000 people. We are proud of our Transitway, bus system, bikeways, greenbelt, and roadway system. Currently, approximately 13 miles of the Ottawa Transitway have been put into operation, along with some ten miles of priority bus lanes. The Transitway has allowed us to gain more productivity out of our buses. With the amount of service we are providing today, we would need 145 more buses if we had not built the Transitway.

The Ottawa Transitway has also been effective in attracting new passengers and maintaining existing riders. Seven out of ten people who work downtown take the bus.

Further, 30 percent of the peak-hour commuters in major travel corridors ride the bus. We also have the highest per-capita ridership of any transit system serving a region of this size in North America. On weekdays, the Transitway carries some 200,000 passenger trips.

Benefits of the Transitway include postponing the need for new and expanded roads, reducing pollution, savings in bus capital expenditures, and reducing operating costs for line-haul services. Public support for the Transitway is strong. The system has also generated worldwide interest. In the last month alone, we have had visitors from Japan, China, Hong Kong, and from cities in the United States and Canada.

Within three years we will have another three miles of the Transitway in operation and an additional ten miles are in the planning stage. On Wednesday we will be opening the first freeway bus lane in Ottawa. This is a four-mile bus-only lane on the shoulder of Highway 17. This lane is expected to carry some 4,000 bus riders during the morning peak hour.

Again, welcome to Ottawa-Carleton. I hope you have a productive conference and an enjoyable stay in the area.

Canadian Perspective on HOV Facilities

Alan Ian Cormier
Canadian Urban Transit Association

Thank you very much for inviting me to participate in your conference on HOV facilities. I would like to provide a Canadian perspective on HOV applications. Because of my role in public transportation, the overview will be from a transit perspective.

Let me first take a moment to provide you with an update on the general state of public transit in Canada today. No doubt you are all aware of the recession that has had North America in its grip for the last few years. Urban transit has not been spared from the effects of the economic slowdown. Transit ridership in many areas has unfortunately been stagnant or declining over the last couple of years—notably in well established urban centers of central Canada, such as Toronto and Hamilton.

However, we maintain an optimistic view for the future. It is towards the future that we are developing plans to increase transit ridership and transit's share of the total urban travel market. It will take the combined and coordinated efforts of many groups to accomplish this.

The Canadian Urban Transit Association (CUTA) represents providers of urban transit services, suppliers, and related organizations in Canada. Our mission is to promote the role of urban transit in enhancing mobility, and to support our members in the fulfillment of their mandate.

CUTA has undertaken a major effort in this direction with its "modal shift to transit" project. The objective of this recently completed study was to identify short- and long-term measures that could be implemented by all levels of government—and by the transit industry itself—to help effect a modal shift to transit. Our goal is to double transit's share of the market within ten years—a goal which we believe is attainable.

The study was conducted by a team of consultants representing different disciplines in transportation, management, financial management, and taxation. The study findings included the fact that current socio-demographic trends are negatively affecting transit ridership, and that increased transit ridership is critical to addressing major urban issues such as traffic congestion, air quality, and the quality of urban life. Further, the study found that in order to increase the productivity of the existing urban transportation infrastructure and accommodate future economic growth, increased transit ridership is essential.

The study concluded that a doubling of transit ridership is possible in the foreseeable future, but that such a goal will only be realized if there is cooperation from all levels of government. It was found that some cities already have some of the required initiatives in place, and that many are transferable from center to center.

The findings of this study, and our resulting "vision" for transit in Canada, are placed well within the North American context. Canada's urban centers, including many medium and smaller centers, suffer from the same problems associated with traffic congestion and deteriorating infrastructure that face cities in the United States.

In addition, customer expectations are rising. Providing customer-oriented service is now critical to our success. Many transit systems have responded to this need by implementing a higher standard of service. For example, air conditioning is now standard on buses in many cities, as are a range of features to make riding easier for many customers. Some examples include kneeling buses, priority seating, larger signs, and our most recent commitment—the introduction of the low-floor bus to help customers with mobility restrictions.

In addition, transit officials have been working with municipal and provincial planners to develop and implement transit-supportive land use guidelines. For example, the province of Ontario has released a report calling for all municipalities to re-evaluate their official plans, ensuring that future developments support transit use by creating pedestrian-friendly projects and nodes of higher-density development. Toronto, Montreal, and Vancouver are each updating their official plans to call for much more transit facilities in the future.

I would now like to provide a brief summary of the transit and HOV applications as they exist in Canada today, and as they stand approved for development in the near future. Here in Ottawa, you will find one of the finest and most extensive networks of transit-only lanes in North America. Operated by the Ottawa-Carleton Regional Transit Commission (OC Transpo)—the regional public transit agency—the Transitway links suburban areas of Ottawa with the central core. Here, the definition of a high-occupancy vehicle includes only red-and-white buses, because the Transitway consists of bus-only lanes on fully separated rights-of-way, with limited stops and fast travel times. I am sure that you will hear much more about the Ottawa Transitway during the conference.

Across the country, a number of other cities have implemented or are adding to transit-HOV projects. Just across the river from Ottawa, the city of Hull operates bus-only lanes along a major downtown arterial street.

In Toronto, transit and taxi diamond lanes have been in place for a number of years. One of the most successful examples is the Bay Street "urban clearway." Running for approximately 3½ kilometers from north of Bloor Street to Front Street, the curb lanes in both directions are reserved for transit vehicles, taxis, and bicycles on weekdays from 7:00 a.m. to 7:00 p.m. This system has reduced travel times for transit vehicles, allowing more efficient use of existing resources and attracting new riders to the transit service on the street.

Another example of a transit-HOV lane is located in the west end of the metropolitan Toronto area. This system, which links two municipalities along the busy Dundas Street corridor, is open to buses and automobiles with three or more occupants. The transit-HOV lane is in effect during weekday peak periods and extends from Dixie Road to the Kipling Subway terminal, a distance of well over six kilometers.

A new project is currently under development in Mississauga—just west of Toronto—that will add transit lanes to an existing freeway corridor. The lanes are the first step towards implementing a busway similar to the Ottawa Transitway. Also in Toronto, proposals have been made to develop exclusive rights-of-way for light rail vehicles such as those in place on the Harbourfront and Queensway corridors.

The Montreal region includes a growing number and variety of transit-HOV lanes. One of the earliest traverses the Champlain Bridge across the St. Lawrence River. During peak hours, buses use a contraflow lane to make the crossing from Montreal's South Shore area. The lane is separated from opposing traffic by manually placed cones and special signs.

Another contraflow lane example is along Pie IX Boulevard, a major north-south arterial street located in the east end of the city. During peak hours, buses travel in a peak-direction only contraflow lane. The lane is delineated by traffic cones, overhead signs, special traffic signals, and flashing arrows on the fronts of the buses. Passengers can access the system by special stations located in the median of the street.

Additional examples of reserved transit and taxi lanes exist along two major arterial corridors from two mid-city areas to downtown Montreal. Transit service is provided by regular and R-Bus routes. The R-Bus routes provide frequent, rapid, peak-hour bus services. This new service, which was just implemented in September, has been so popular that service levels have already been increased significantly on both routes. Another example is a bus-only lane on a major bridge linking Montreal and Laval, a city to the north. In addition, a number of other transit lanes also exist in the city.

In Quebec City, curb lanes along a major arterial corridor are used for mainline bus service. Frequent bus service provides the backbone of a restructured network, linking downtown with other major traffic generators in the city, including a major university and shopping areas.

Other Canadian cities also have examples of transit and transit-HOV lanes. Halifax in the east and Edmonton in the west have created transit-only throughways, allowing transit to bypass congested points in the street network, or to take shortcuts not available to regular traffic.

In Vancouver, a paved shoulder along a freeway south of the city allows transit vehicles to bypass peak-hour traffic back-ups at a bottleneck where the highway narrows to pass through a tunnel. Another planned example on the west coast is the Barnett Highway link between Vancouver and Coquitlam, a suburb to the east of the city. The highway, which serves as a primary link between the two points, is currently a two-lane facility. It is scheduled to be rebuilt to three lanes, including a center, reversible transit-HOV lane.

In short, the concept of reserved transit and transit-HOV lanes is becoming very widely applied and accepted in Canada. Currently, the majority of this country's examples are indeed transit-only lanes, as opposed to bus, vanpool, and carpool lanes. This is not to be interpreted as an anti-automobile approach. Indeed, we believe that the automobile will be part of the Canadian urban environment for many years to come. However, we also believe that if the world is to survive as we know it, transit must play a larger role. Through the continuing implementation of transit-HOV projects, Canadian cities will thrive in the future.

In these tough economic times, it would be easy to say that we simply cannot afford to implement new highway projects, but Canadians are learning that making more effective use of the existing urban infrastructure is critical. We cannot afford to build a never-ending network of more and wider roads and expressways. We are learning to reevaluate our needs and redirect our resources towards developing an urban structure that is more oriented to persons and to mass transit. This will be accomplished by implementing transit-oriented land use guidelines, and by designing transit priority and high-occupancy vehicle lanes using existing roads and freeways.

In this way, we believe that this country will be able to meet the urban challenges of the future. I hope you find the next few days to be most informative, and may I take this opportunity to again welcome you to Canada and the conference.

Status of HOV Projects and Activities

Katherine F. Turnbull
Texas Transportation Institute

A number of people deserve credit for helping organize the conference this year. Rich Cunard and the TRB staff did their normal outstanding job in taking care of the arrangements with the hotel, John Bonsall and his staff have organized the local activities, and Don Capelle and other members of the TRB HOV Systems Committee have assisted in organizing the workshop sessions. The efforts of all these people deserve to be recognized.

It is a pleasure to have the opportunity to provide an overview of recent HOV projects and activities. A great deal has happened since the previous National Conference on HOV Systems in Seattle, which was held in the spring of 1991. I think you will see the continued high level of interest in HOV facilities reflected in the workshops and the general sessions of this conference. The Intermodal Surface Transportation Efficiency Act (ISTEA) and the federal Clean Air Act Amendments (CAAA) have focused a good deal of attention on transportation in general and HOV projects in particular.

I would like to provide a brief summary of recent HOV projects and activities in North America. Further, I want to note how these efforts fit into the workshops you will have the opportunity to attend over the next two days. The workshops have been organized around current topics of interest and should provide you with the opportunity to discuss issues of mutual concern.

Currently, there are some 49 HOV projects in operation on freeways or separate rights-of-way in 22 North American metropolitan areas. Further, HOV lanes have been implemented on arterial streets in numerous cities. Many areas with HOV lanes are expanding existing facilities and developing additional projects. In addition, new HOV facilities are being developed in a number of areas where none currently exist. Finally, planning studies examining HOV alternatives are being conducted in many metropolitan areas that previously have not considered HOV projects.

The continued interest in HOV facilities is reflected in the growing number of lane-miles of HOV projects in operation in North America. Currently, there are approximately 380 lane-miles of HOV lanes in operation on freeways or separate rights-of-way. If all the projects that are in the planning, design, and construction phases are completed, there will be over 1,000 lane-miles of HOV projects in operation by the year 2000.

A quick trip around North America provides an idea of the number and nature of new HOV facilities. On the West Coast, some ten miles of the Route 57 concurrent flow HOV lanes were recently opened in Orange County, California. Initial indications are that the facility is well-utilized with peak-hour volumes of some 1,000 vehicles at a 2+ occupancy requirement. In Seattle, an interim HOV lane has been in operation on I-5 South for almost a year. This facility, which operates with a 3+ vehicle occupancy requirement, has been averaging about 500 vehicles during the morning peak hour, carrying some 2,500 people.

The grand opening of the I-394 project in the Minneapolis area occurs this week. This facility includes a three-mile segment of two-lane, reversible, barrier-separated HOV lanes and eight miles of concurrent flow HOV lanes. In addition, park-and-ride lots and bus transfer stations are located along the corridor. The project also includes three large parking garages on the edge of downtown Minneapolis. A direct connection is provided from the HOV lanes to the garages, which offer reduced parking rates for carpoolers, bus staging and transfer areas, and connections to the downtown skyway system. The different elements of the project have been opening in stages over the last few years, but the total project is now complete.

Another new project in the Minneapolis-St. Paul area is the Intercampus Busway. This facility will ultimately connect the Minneapolis and St. Paul campuses of the University of Minnesota. Approximately 1½ miles of the three-mile exclusive busway have been opened. The full facility will be completed in the summer of 1993.

In the Dallas area, the East R. L. Thornton (I-30E) HOV lane represents the first use of a moveable concrete barrier with an HOV facility. The East R. L. Thornton HOV project is a contraflow lane that operates only during the peak periods. The moveable barrier is used to transform the median lane in the off-peak direction into a peak-direction HOV lane. The project has been very successful, averaging approximately 1,350 vehicles and 4,300 people during the morning peak hour.

Additional information will be provided on the East R. L. Thornton and I-394 HOV lanes in the workshop on new projects. Information on the abbreviated operation of the Dulles Toll Road HOV project in Northern Virginia will also be provided at that workshop. Recent Congressional action has required the removal of the HOV restrictions on that facility for a period of time.

In the southern portion of Virginia, recently opened HOV lanes in the Norfolk/Virginia Beach area have been well-received and are being well-utilized. The I-64 HOV lanes, which use a 2+ vehicle occupancy requirement, have surpassed the preliminary volume projections. In the first few weeks following its opening, some 800 vehicles—carrying approximately 1,520 people—were using the facility during the morning peak hour. This is a much more positive response than the reaction to the initial HOV efforts in that part of Virginia a few years ago.

The vehicle occupancy requirements have been changed on some HOV projects over the past year. A 3+ occupancy requirement during the evening peak hour was implemented on Houston's Katy HOV lane about a year ago. This requirement matches the 3+ designation in the morning peak hour that was implemented in 1988. Both changes were made to address increasing congestion levels that were affecting the travel time savings and reliability offered by the HOV lane. The Katy HOV lane is still the only HOV lane that uses a different vehicle occupancy requirement during the peak hour. Elsewhere, the vehicle occupancy requirement has been lowered from 3+ to 2+ on both the I-5 North HOV lanes in Seattle and I-279 HOV lanes in Pittsburgh. In addition, a similar change is scheduled for the I-84 HOV lanes in Hartford. These changes were made in response to the perception that the facilities were under-utilized with a 3+ requirement. The impacts of the changes in occupancy requirements will be discussed in one of the workshop sessions.

There have been two significant activities in the area of design guidelines since the last HOV conference. Both the Institute of Transportation Engineers (ITE) and the American Association of State Highway and Transportation Officials (AASHTO) have recently published design guidelines for HOV facilities. These guidelines build on existing publications and further enhance the level of knowledge related to HOV design issues. Both of the guides, as well as recent design-related activities in Canada, will be discussed at a workshop session today.

One of the benefits of having the conference in Ottawa is the ability to focus more on bus applications with HOV facilities. Workshop sessions have been organized to examine bus operating scenarios, bus service orientation, supporting facilities and services, and other elements critical to the success of HOV projects. In addition, the use of supporting policies and programs will also be discussed in one of the workshops.

The interest in arterial street HOV applications, which was evident at the Seattle conference, continues to grow. This interest appears to stem from a number of different perspectives. Arterial street HOV lanes are being considered as stand-alone projects, as links between major activity centers, and as connections between freeway HOV lanes and major destinations. In addition, the use of arterial street HOV facilities by carpools, rather than just the traditional bus-only approach, is being examined. All of these concepts are being considered in many metropolitan areas. Recent projects and studies in Snohomish County, Toronto, and Hartford will be discussed in one of the workshops.

The application of IVHS technologies with HOV facilities has also generated a good deal of interest and enthusiasm over the past year. There are a number of projects currently in operation that combine HOV and IVHS applications and many more are in the planning stage. One example of IVHS technology currently in use with an HOV facility is on the eastbound approach to the Lincoln Tunnel in the New York City area. Buses using this facility are equipped with automatic vehicle identification (AVI) tags. In combination with a reserved bus-only lane, this technology allows commuter buses to move through the congested toll plaza without stopping. The AVI tags are detected by a reader at the toll plaza and the toll charge is electronically deducted from a pre-paid account. This has provided buses with travel time savings in addition to those afforded by the 2½-mile contraflow lane.

As John mentioned, a number of advanced technologies are being implemented in Ottawa to improve bus operations and to enhance passenger information. The development of an automatic vehicle location (AVL) system represents one of these projects. This system is being used to improve the operation and management of the transit system and to provide real-time information on the status of buses to customers. You will be able to see the AVL tags and overhead readers on the tour tomorrow. You will also have the opportunity to see the video monitors currently used for passenger information.

Another project that combines HOV and IVHS technologies is the Houston *Smart Commuter* IVHS Operational Test. This project is moving forward in the Houston area through the joint efforts of the Metropolitan Transit Authority of Harris County (METRO), the Texas Department of Transportation (TxDOT), FTA, FHWA, and TTI. This project will test the provision of real-time traffic and transit information to individuals in their homes and places of work. The impact this information has on encouraging a mode shift from driving alone to carpooling or using transit will be monitored and evaluated. Changes in travel times or travel routes will also be examined. The overall goal of the project focuses on improving the efficiency of the travel corridor.

Another topic that continues to generate a good deal of discussion is the enforcement of HOV lane operating requirements. Advanced technologies may help address some of the issues and concerns related to HOV enforcement. Past studies have indicated limitations with many technologies that could assist in enforcement activities. However, recent advances in numerous technologies may overcome some of these limitations. A demonstration project is being initiated in the Dallas area that will explore potential approaches and will test some of the more promising technologies.

It has also been suggested that barrier-separated HOV lanes provide an ideal environment to test and implement many of the advanced vehicle control and navigation technologies. Currently, the I-15 HOV lane in San Diego is being used by the California Department of Transportation (Caltrans) during the off-peak periods—when it is not open to HOVs—to test some of the advanced vehicle technologies being developed in California. Other HOV facilities around the country may be used for similar purposes in the future.

Air quality issues continue to be a major concern in most metropolitan areas today. As a result, the role HOV facilities can play in improving air quality levels is being examined more closely in many areas. One of the workshops tomorrow will focus on the current understanding of the relationships between air quality and HOV facilities. This is an area that has been identified as a priority for additional research by the TRB HOV Systems Committee.

Another topic the TRB HOV Systems Committee has been exploring is the international experience with HOV facilities. A number of innovative approaches are being used in cities throughout the world. For example, guided busway systems are in operation in Adelaide, Australia and Essen, Germany. Further, a variety of bus-only lanes are in operation in cities in Europe, South America, and

East Asia. Many of these facilities use other priority techniques, such as signal preemption, to provide additional advantages to buses. In addition, a few projects currently include carpools, and bus and carpool lanes are being considered in more areas. One of the workshop sessions focuses on international HOV applications and we are pleased to have people attending this conference from a number of countries around the world.

In summary, traffic congestion continues to be a significant problem for most metropolitan areas in North America and throughout the rest of the world. HOV facilities provide one approach that may be appropriate to help address traffic congestion, mobility, and air quality concerns in these areas. However, HOV facilities are not the only approach, and they may not be appropriate in some situations. Further, HOV projects should not be viewed as the total solution. Other facilities, programs, and services will continue to be needed to adequately address the concerns facing metropolitan areas today.

I hope you will find the general sessions and workshops to be informative. Further, I hope they will challenge you to continue to think creatively about solutions to the transportation issues facing our metropolitan areas today.

ISTEA and HOV Facilities in the United States

Dennis L. Christiansen, Texas Transportation Institute — presiding

Federal Transit Administration Perspective

Donald J. Emerson
Federal Transit Administration

It is a pleasure to be here in Ottawa and have the opportunity to speak at this conference. My charge this morning is to talk about the Intermodal Surface Transportation Efficiency Act and provide a perspective on the transit-related aspects of the act. As many of you know, the ISTEA has made major changes in the federal, state, and local partnerships that fund transportation projects in the United States. The ISTEA authorized approximately $150 billion for the six-year transportation program. In addition to the actual authorization of funding, the ISTEA established the procedures and rules governing the use of those funds.

"Intermodal" is the first word of the act, and there has been a good deal of discussion on defining intermodalism and how it differs from multimodal. For those of us involved in HOV planning, intermodalism is not new. HOV projects have historically involved a mix of modes. The exact definition of intermodalism is still evolving, however, as the regulations and procedures outlined in the act are being developed by the different responsible agencies.

I would like to focus my comments this morning on how the ISTEA has influenced the various federal funding programs administered by FTA. I would also like to provide a few examples of how these programs are being used to implement HOV and busway projects. Finally, I would like to review the procedures that have been developed regarding the sharing of responsibilities between FTA and FHWA.

The Section 9 program, which is authorized at approximately $16 billion over the six-year period, is intended to cover the routine needs of transit systems. Funding is allocated by a formula that considers urban population and service factors. In the early years of the program there was also some funding available for system expansion. This is no longer the case in most areas, however. Further, as needs have continued to grow, funding levels have not always been adequate. Many areas are also being pressed to meet the requirements of the federal Americans with Disabilities Act and the Clean Air Act Amendments. The 1993 Section 9 appropriation represents about ten percent of the six-year authorization.

The Section 3 program is not based on a formula, but rather is largely a discretionary program. It is authorized at $12.4 billion over the six-year period. For 1993, the appropriation is for Section 3 is $1.725 billion. The three categories within Section 3 and their funding levels are: new starts (40 percent), fixed guideway modernization (40 percent), and bus (20 percent).

The new start category is designed for large, one-time only investments in fixed guideway projects. This section is typically considered the funding category for new rail transit projects. These projects require large expenditures of funds in relatively short time periods. The new start category has also been used to fund HOV lanes and transitways. For example, new start funds were used on some of the Houston HOV lanes and the North I-25 HOV lane in Denver.

The ISTEA earmarked approximately 40 projects for new start funding over the six-year life of the act. Some of these involve HOV projects. Examples include the Multimodal Transit Parkway in Los Angeles, the South Boston Pier Transitway, and the Houston HOV lanes. One problem is that the cost of all these earmarked projects is greater than the total amount of available funding. Thus, there will be competition among the earmarked projects for annual appropriations. FTA evaluates projects on an annual basis and makes recommendations to Congress on how the funds ought to be spent. Projects are rated on a number of different elements including project justification and the source and stability of local funding.

The second Section 3 category is fixed guideway modernization. These funds are allocated by a formula established in the ISTEA. A major share of funds in this category are allocated to cities with old rail systems. Cities like Boston, New York, Chicago, and Philadelphia can use these funds to upgrade older rail systems. The formula includes any type of fixed guideway system, however. HOV lanes over seven years old are included in this category.

The bus program is the last category of funding in Section 3. This program is for extraordinary bus needs that cannot be met through Section 9. HOV projects may be eligible for funding through this category. In 1993, all of the funds available within this category have been earmarked by Congress. One of the earmarked projects involves building park-and-ride lots associated with the Dulles Toll Road HOV lane, a project that is no longer in operation. It will be interesting to see how this works out.

Within the ISTEA, there are a series of flexible funding programs under Title 1, which is the highway portion of the ISTEA. Funds within those programs can be used for either highway or transit projects. These include the National Highway System program, authorized at $21 billion, the Surface Transportation Program, authorized at $23.9 billion, and the Congestion Mitigation and Air Quality Program, authorized at $6 billion. Funding from those programs is potentially available for both highway and transit projects.

I would like to use the Pittsburgh Airport HOV/busway project as an example to demonstrate how the ISTEA may work in actual practice. The project is a proposed two-lane, eight-mile HOV/busway from downtown Pittsburgh to the airport. Eight stations are proposed, along with a new HOV bridge into the downtown area, and the conversion of the Wabash Tunnel into an HOV facility.

The Port Authority of Allegheny County (PAT) has been the lead agency on the project. The initial concept focused on a busway to be funded out of the transit program. Following the passage of the ISTEA, PAT contacted the Pennsylvania Department of Transportation (PennDOT) concerning the availability of flexible funding through the Surface Transportation Program (STP). PennDOT indicated an interest in exploring possible funding, but suggested that HOV use of the busway be considered. As a result, a carpool/vanpool alternative was added to the Environmental Impact Statement (EIS) process. The Draft Environmental Impact Statement (DEIS) is currently being circulated for review and comment, and a decision is expected soon regarding the locally-preferred alternative.

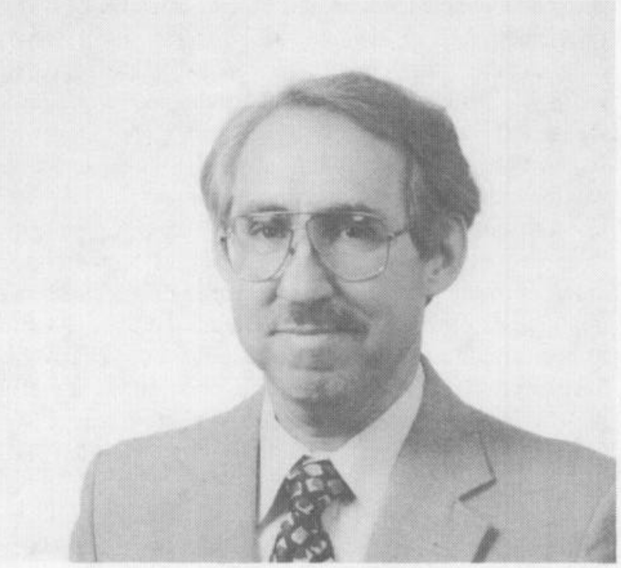
The institutional relationships that developed on this project are interesting. Although PAT took the initial lead, and is still the lead agency, they are working closely with PennDOT. Further, FTA and FHWA are working together on the federal EIS. The financing plan being developed includes a package of highway and transit funds. Funding sources include Section 3, STP/CMAQ, ISTEA earmarks, local bonding, and other local sources.

I would like to close by discussing some of the administrative aspects of the ISTEA flexible funds. In general, FTA will manage projects that are clearly transit, while FHWA will manage projects that are clearly highway-oriented. Decisions concerning intermodal projects will be made on a case-by-case basis. HOV facilities may fall within those projects that will be determined on an individual basis.

In conclusion, the ISTEA represents a major milestone in the partnership between federal, state, and local transportation agencies. New procedures, new relationships, and new roles will be needed to take advantage of the flexible funding and other requirements of the ISTEA. It will take time to determine the appropriate approaches and to fully understand the opportunities offered by the act. The Pittsburgh project is one example of an approach that can be used to develop busway/HOV projects.

Federal Highway Administration Perspective

Sheldon G. Strickland
Federal Highway Administration



It is a pleasure to be able to participate in the Sixth National Conference on HOV Systems. The Federal Highway Administration is pleased to help sponsor the conference along with the Federal Transit Administration. I would like to thank the Ottawa-Carleton Regional Transit Commission and the Ontario Ministry of Transportation for their sponsorship of the conference as well.

I am very optimistic about the future of HOV facilities as a result of provisions of the Intermodal Surface Transportation Efficiency Act. I would like to cover three topics this morning. First, I want to discuss the provisions of the ISTEA that clearly support the potential of HOV facilities. Second, I would like to provide you with an overview of HOV-related activities by federal regions. Finally, I would like to discuss the potential of other ISTEA provisions to greatly expand the inventory of HOV facilities.

As you are aware, the number of miles of operating HOV lanes has greatly increased in the United States since 1969. Currently, slightly over 350 center-line miles are in operation. The increased popularity and demonstrated effectiveness of HOV facilities may have influenced Congress to include the HOV provisions in the ISTEA. There are four primary provisions in the ISTEA that address HOV facilities. These are Congestion Mitigation and Air Quality (Section 1008), Interstate Maintenance (Section 1009), Metropolitan Planning (Section 1024), and Statewide Planning (Section 1025). I would like to briefly discuss the aspects of each of these provisions as they relate to HOV projects.

The Congestion Mitigation and Air Quality (CMAQ) program (Section 1008) states that, "No funds may be provided under this section for a project which will result in the construction of new capacity available to single-occupant vehicles unless the project consists of a high-occupancy facility available to single-occupant vehicles only at other than peak travel times." The CMAQ program is a $6 billion, six-year effort aimed at congestion mitigation and improving air quality. The program is focused only on metropolitan areas that have been designated as air quality non-attainment areas.

Currently, over 60 percent of the U.S. population lives in metropolitan areas classified as non-attainment areas. Further, 61 of the 75 metropolitan areas with populations of over one-half million people are classified as non-attainment areas. Of these, only about 28 currently have any type of HOV facility in operation. If any of the non-attainment metropolitan areas plan to use CMAQ funds to increase capacity, they must consider HOV facilities.

In addition, under ISTEA the only projects eligible for 90 percent federal funding through the Interstate Maintenance Program are HOV facilities. The Interstate Maintenance Program (Section 1009) provides that the "activities authorized shall not include the construction of new travel lanes other than high-occupancy vehicle lanes or auxiliary lanes."

Metropolitan Planning (Section 1024) also addresses HOV facilities. Although this section does not say anything specifically about HOV projects, the wording very clearly reflects HOV facilities. The section indicates that funds should be used "to make the most efficient use of existing transportation facilities to relieve vehicular congestion and maximize the mobility of people and goods." The section states that in non-attainment metropolitan areas with populations over 200,000, "federal funds may not be programmed for any highway project that would result in a significant increase in the carrying capacity for single-occupant vehicles, unless the project is part of an approved Congestion Management System." Additional rule-making currently underway at FHWA and FTA will further support these requirements.

Statewide Planning (Section 1025) further supports these efforts at the state level. This section states that "each state shall undertake a continuous transportation planning process which shall reduce traffic congestion including methods which reduce motor vehicle travel, particularly single-occupant motor vehicle travel." You can see that the focus here continues to be on moving people, rather than vehicles. Thus, state departments of transportation must deal with congestion on a statewide level, they must cooperate with the metropolitan planning organization (MPOs), and in non-attainment areas with populations over 200,000 consideration must be given to HOV facilities in planning and programming activities.

So how are we doing? Are the states using ISTEA funds for HOV projects? Table 1 shows that the amount of funding obligated from the ISTEA, including CMAQ, in FY 1992 for HOV projects was about $212 million. This was obligated in a nine-month period. The $2.8 million in CMAQ funding went to just two projects. Thus, funding through CMAQ has not really been maximized for HOV projects yet. Most of the ISTEA funding for HOV facilities is being used in federal regions 3 and 10. However, there are a large number of HOV projects in other regions, especially 4 and 9. Thus, there currently does not appear to be a balance between HOV projects and ISTEA funding.

There is more to the ISTEA than just these four elements, however. Other sections of the ISTEA further support the development of HOV facilities. For example, the ISTEA requires the development of a number of management systems in metropolitan areas. Three of these are directly related to HOV projects. States and metropolitan areas with populations over 50,000 are required to have management systems for congestion management, intermodal transportation facilities and systems, and public transportation facilities and equipment. All of these management systems should incorporate HOV facilities in their plans. The Clean Air Act Amendments further require that transportation planning and operations in the future must link the movement of people and goods to the management of congestion. The language in the ISTEA makes it clear that the MPOs must confront congestion, address it where it exists, and prevent congestion for occurring where it does not currently exist. The planning process must develop a long-range plan in which congestion management, intermodalism, and public transportation are linked together to reduce congestion and improve air quality levels. The funding provided by the ISTEA carefully links the planning and transportation improvement plan (TIP) processes. Therefore, eventually HOV facilities will appear on more TIPs as a result of the management systems.

In conclusion, the provisions of the ISTEA are very generous toward HOV facilities. The trends relating to both planning and constructing HOV facilities are also very positive. New projects are being developed and existing ones are being expanded. In addition, many non-attainment areas will need to consider HOV projects. Finally, the management system requirements of the ISTEA support HOV facilities and should lead to expansion of HOV projects.

TABLE 1 U.S. HOV FACILITIES AND ISTEA FUNDING BY FHWA REGION (OCTOBER 1992)

Region	HOV facilities (lane-miles)			ISTEA funds ($ thousands)	
	Planned	Construction	Operational	Total	CMAQ
1	141	37	27	1,200	300
3	134	54	127	90,500	0
4	306	29	140	0	2,458
5	96	0	22	1,770	0
6	21	30	46	8,546	0
7	0	0	0	0	0
8	9	9	13	2,000	0
9	1,064	12	263	0	0
10	124	39	70	107,731	0
Total	1,895	210	708	211,747	2,758

The Emerging Role of Metropolitan Planning Organizations

Jon Williams
Metropolitan Washington Council of Governments

I would like to discuss the impact of the ISTEA on the metropolitan planning process and the implications for HOV facility development. I would like to start by providing an overview of metropolitan and regional planning in the United States.

In 1990, the U.S population was approximately 240 million people, with some 78 percent residing in metropolitan areas. The number of people living in metropolitan areas has increased from approximately 40 million in 1920 to 190 million in 1990. Over the same time period, the population in non-metropolitan areas has declined.

Metropolitan areas in the U.S. are characterized by a complex and often overlapping structure of county, municipal, sub-regional, and state governments. This often makes it difficult to find metropolitan solutions to metropolitan problems. In the area of transportation, the federal government has recognized the need for regional coordination, and since 1962 has required an urban transportation planning process in each metropolitan area. The agencies that coordinate this regional planning process are known as metropolitan planning organizations (MPOs). I am going to assume that we all share the belief that some form of metropolitan coordination is desirable for transportation planning and that we share the same primary goal to find cost-effective solutions to our transportation problems.

The ISTEA has transformed the practice of transportation planning in the United States. There are a number of key features of the ISTEA from an MPO perspective. First, there is additional federal funding available from the Transportation Trust Fund. About 30 percent more funding is available from previous years and a higher percentage of these funds are allocated to MPO planning activities. The overall level of funding available to MPOs has increased by about 75 percent. It appears that the work load for MPOs has increased by some 125 percent, however, so I am not sure how well MPOs really come out with the new legislation.

A second significant feature of the ISTEA is the addition of flexible funding categories. These have changed the entire character of the metropolitan transportation program. Whereas previously the Interstate Program had a relatively inflexible character, there is now far more flexibility in the types of solutions metropolitan areas can use to address transportation problems.

Third, the ISTEA has given project selection responsibilities in many funding categories to the MPOs in consultation with the states. This is a big change from the past, when MPOs were often viewed as just rubber-stamping state plans. This responsibility is somewhat controversial with the implementing agencies. In the final analysis, it appears that the ISTEA gives local governments a greater opportunity to influence which projects are built and operated through the MPO process.

Several of the new planning and program requirements are especially important. One is the need to have a realistic financial program for how the regional plan will be implemented. This constraint was not imposed previously, and thus many plans were often unrealistic. Second, the public participation requirement ensures that the public will be provided with direct participation in the entire planning process. Third, the congestion management system requirement directs the MPO, in consultation with the state, to incorporate demand reduction and operational management strategies into the regional plan.

This requirement is even stronger in air quality non-attainment areas. In those areas, federal funds may not be used for projects which increase highway capacity, unless they are part of an approved Congestion Management Plan. Further, MPOs must ensure conformity between the transportation plan and the air quality plan in non-attainment areas. Also, the MPO planning area must include the non-attainment area. In some cases, this may substantially increase the geographic area covered by the MPO.

The ISTEA has a number of implications for the MPO planning process. As I have noted, the MPO planning area may be expanded to match the air quality non-attainment area boundaries. The MPO area may also be expanded because the ISTEA requires that it matches the area expected to be urbanized within the next 20 years. This provides a more comprehensive geographic scope for the planning process.

The act also requires increased coordination between the planning activities of state, regional, and local agencies. In metropolitan areas, the ISTEA requires that six management systems be developed by the state in cooperation with the MPO. The six management systems are: bridge, pavement, highway safety, public transportation facilities, intermodal transportation facilities, and congestion management. The MPO is the lead agency in the development of congestion management plans. Also, since MPOs have increased responsibility for project selection and since there is much more flexibility in how funds can be programmed, the MPO becomes the focus for competing interests to negotiate project and program desires.

This in turn leads to a greater interest in the MPO planning process. In many areas, representatives from additional agencies and groups are now participating in the MPO process. For example, at WASHCOG, new members include representatives from the transit authority, state legislatures, and smaller local governments. The by-laws have had to be rewritten to accommodate these changes, and new voting procedures have been implemented. Finally, the ISTEA contains specific language guaranteeing that public interest groups are included in the development of the different plans and at all stages in the project selection process. To accommodate this requirement, a public comment period, public forums to discuss major plans and projects, and a public advisory group have all been established at WASHCOG.

The ISTEA obviously creates some exciting opportunities for MPOs and for metropolitan planning. For example, there is an opportunity to strengthen the relationship between land use, environmental concerns, and transportation plans and programs. The increased flexibility under ISTEA allows the selection of projects that may advance land use planning objectives, clean air planning goals, and land use actions that will create transit- and pedestrian-friendly environments. There is almost a mandate in the ISTEA for the MPOs and the states to shift from an emphasis on developing the transportation system to managing and preserving existing facilities. Further, there is an opportunity to promote bicycle and pedestrian projects, historic preservation projects, and to select, fund, and build high-leverage intermodal projects. The flexibility features of the act permit selection of projects that could have a very high pay-off, including HOV projects and HOV facilities.

I would like to talk briefly about how the ISTEA may influence the decision to implement HOV projects in the Washington, D.C. metropolitan area. Prior to the adoption of the ISTEA in 1991, many metropolitan areas had initiated plans that included major investments in HOV facilities. These projects were a response to the inadequacy of traditional capacity expansions needed to meet forecast demand, funding shortages, environmental concerns, and other factors that supported the movement of people rather than vehicles. In addition, ISTEA gives encouragement to HOV projects at the metropolitan and state level. Aspects of the act favoring HOV projects include 90 percent funding through the Interstate Maintenance Program and the congestion management requirements.

Currently, there are a number of HOV lanes in the Washington, D.C. metropolitan area. Freeway HOV facilities include the barrier-separated lanes on the Shirley Highway, the concurrent flow HOV lanes on I-95, and the I-66 facility. Two short arterial street HOV lanes are also in operation in Alexandria, Virginia. The programmed HOV lanes include extensions to the Shirley Highway HOV facility and the Dulles Toll Road HOV lanes. A number of other facilities are also being proposed. One might question whether all of these are cost-effective projects that will have public support.

The Dulles Toll Road HOV lanes provide a recent example of a project that did not have strong public support. The 12-mile facility was opened on September 1, 1992. Within a month there had been a large public outcry against the project and the United States Congress had become involved. On October 5, 1992, the state of Virginia withdrew the HOV restriction for a year. This represents an experience that most people would like to prevent recurring in the Washington, D.C. area and elsewhere.

With this experience in mind, I would like to close by discussing a few considerations for HOV development in light of the ISTEA requirements and the new MPO responsibilities. First, transportation planning should be based on examining alternatives, not promoting pre-determined results. HOV facilities may not always be the best solution and they should not be promoted in these situations. Second, in those cases where HOV lanes are the best solution, the public must be educated and their support should be sought for the facilities. Resources need to be allocated from project funds for this purpose. Third, HOV facilities need to be designed and operated in a safe and enforceable manner. Fourth, HOV systems should be planned that include park-and-ride lots, transit services, enforcement, and employer programs as integral components. Fifth, priority treatments may take many forms and could include ramp meter bypass lanes, congestion pricing, and bus-only lanes.

There is a danger that funds may be allocated to HOV lanes because it is the easy thing to do, rather than the right thing to do. The MPO will play a critical role in helping to identify cost-effective HOV projects. The MPO's project selection responsibility for the flexible programs is very important in this regard. This does not give them independent powers, however, as MPOs are primarily a forum for state and local discussion. Rather, it suggests two ways that MPOs can be helpful. First, MPOs provide an opportunity to involve all groups in the metropolitan area in the planning and project selection process. Second, MPOs have the potential to ensure that system planning occurs and that narrow-based unpopular projects with inadequate supporting facilities are not funded.

Currently, MPOs and others are just beginning to discover how to take advantage of many of the new programs and the flexibility offered by the ISTEA. It appears that MPOs have the potential to make the planning and design process a rigorous one that will produce successful HOV projects and programs.

Maximizing the Benefits of the ISTEA

Peter Peyser
Peyser Associates, Inc.

I would like to thank the organizers of the conference for the opportunity to provide an update on a number of elements related to the ISTEA and the HOV Coalition. The credit for many of the ISTEA provisions related to HOV facilities goes to the members of the HOV Coalition. The coalition is a public/private organization established in 1989 to advocate HOV projects at the national level. Members include Seattle Metro, Denver RTD, Los Angeles County Transportation Commission, Parsons Brinckerhoff Quade & Douglas, The American Bus Association, and Greyhound Lines.

The HOV Coalition promoted several goals during the development of the ISTEA. Three critical elements standout. The first was to provide preferential matching ratios for HOV projects. The 90 percent federal matching ratio in the Interstate Maintenance Program certainly reflects this preferential treatment for HOV projects. The set-aside provision for transportation enhancements within the act further supports the development of HOV projects. The coalition also pushed for a special category of funding for HOV projects. The Congestion Mitigation and Air Quality (CMAQ) program reflects many of these concerns. Third, the coalition supported broad eligibility for HOV projects. The coalition promoted the inclusion of HOV projects in the different categories within the highway and the transit programs. I think this goal was also accomplished, as HOV projects are mentioned in many parts of the ISTEA.

As noted by other speakers, an important reason for this approach was the link to the Clean Air Act Amendments of 1990. It appears that the HOV Coalition was successful in most of its efforts. However, implementing HOV projects is not always an easy process and the ISTEA itself does not guarantee that HOV facilities will be developed. We have been working with a number of large transit agencies, the U.S. Conference of Mayors, and many other groups during the implementation of the ISTEA. We are finding that the experience with HOV projects may not be as positive as we had hoped it would be, although numerous opportunities exist.

There does appear to be a good deal of inertia working against HOV projects in many of the major metropolitan areas that needs to be overcome. This inertia exists at both transit agencies and state departments of transportation. Both types of agencies tend to have numerous projects of a more traditional nature in the planning and programming pipeline. Many transit agencies have bus replacement needs and plans for new bus garages or new rail systems. State highway departments always have needs for resurfacing projects or other system enhancements. It is very difficult to go to those agencies with maintenance responsibilities for the bus, rail, and roadway systems and try to get them to focus on more non-traditional types of projects like HOV facilities.

Thus, there does not appear to be any real ownership of the HOV concept at the agencies responsible for implementing these projects. The fact that HOV projects were not viewed as threatening to transit or highway agencies may have helped during the legislative process. This benefit may be somewhat of a deterrent during the implementation process, because these agencies may not feel a commitment toward HOV projects. Those of us who live in the Washington, D.C. area are also aware of the public misgivings toward HOV projects. One of the lessons I think we can learn form the Dulles Toll Road project is the need to take a systems approach to the development of HOV facilities.

Although most people think there is a positive link between HOV facilities and improving air quality levels, environmental groups in some areas do not favor HOV lanes or any project that presents an opportunity to improve the highway.

Finally, there appears to be some confusion over how MPOs will conduct the planning and project selection process for allocating funds for the different ISTEA programs. You need to look at the experience to date with many of these programs to understand this concern. Other speakers have discussed many of the issues relating to how these funds may be used. As indicated, approximately 90 percent of the funds allocated for HOV projects through the flexible highway programs have gone to just two regions. Thus, there appears to be a need to provide more information on the availability of funding through the various highway programs.

Similar needs exist with transit programs also. According to FTA, approximately $241 million has been programmed from the Surface Transportation Program and CMAQ for transit purposes in FY 1992. In addition, some $58 million in FY 1993 funding has been allocated. Approximately half of this $300 million is being spent in the New York City metropolitan area. Further, all these funds are being used for either traditional transit projects—bus garages, new buses, and other capital projects—or to a lesser extent, projects to comply with ADA and CAAA requirements. In general, these funds are not being used for HOV lanes or similar projects. The proposed airport HOV lane in Pittsburgh linking the airport and the downtown area provides one exception to this trend.

I would like to close by noting a few of the activities that I believe are necessary to take full advantage of the funding opportunities for HOV facilities. Clearly, advocates for HOV projects need to understand that the ISTEA presents the opportunity for HOV projects, but it does not guarantee that any projects will be funded or constructed. Coalitions will need to be developed in different areas to take advantage of the flexibility of the new federal programs. These coalitions will need to include environmental groups as well as transit agencies, MPOs, and state transportation departments. Further, coordination with IVHS activities and projects will be important. IVHS is currently receiving a good deal of attention and there are many natural ties with HOV facilities. Finally, businesses and major employers need to be involved in the process.

As an HOV advocate, I am very excited about the opportunities available through the ISTEA. However, there is a good deal of work to do before the benefits of this legislation will be realized in terms of new HOV projects and facilities.

HOV Facilities in Canada

John A. Bonsall, Ottawa-Carleton Regional Transit Commission — presiding

Development of the Ottawa Transitway System

John A. Bonsall
Ottawa-Carleton Regional Transit Commission

Mr. Bonsall provided an overview of the development and status of the Ottawa Transitway and bus lanes. He also showed a video of the system. The following major points were covered in his presentation and in the video.

- The Regional Municipality of Ottawa-Carleton was formed in 1968. One of the charges given to the regional governments by the provincial government was the development of a regional plan. The original plan for the Ottawa-Carleton region was approved in 1974. At that time there was strong sentiment against building more freeways. Thus, the plan approved in 1974 contained a major policy thrust supporting public transit.

- In response to the adoption of the regional plan, planning for a transitway system was initiated in the mid-1970s. An appraisal study was conducted first to examine the need for rapid transit based on different future population projections. Alternative technologies capable of meeting these needs were also examined. In addition, two different development strategies were studied. One focused on the more traditional approach of developing the more expensive downtown portion of the system first, while the second focused on building the outlying portions first and delaying the downtown section.

- The study confirmed the need for a rapid transit system capable of carrying peak-hour, peak-direction volumes of some 15,000 passengers. The study further recommended the second approach to the development of the system. More detailed analyses were then conducted to determine the alignments in each corridor. Finally, a technology evaluation study was conducted comparing bus and light rail options. The busway alternative was selected due to lower capital and operating costs, a higher level of service, and greater flexibility.

- The first segments of the Ottawa Transitway were opened in 1982. Currently, some 13 miles are in operation, with additional bus-only lanes on streets in the downtown area. The Transitway is located on a separate right-of-way and consists of one lane in each direction, with shoulders on both sides. Stations are located at strategic points and some are tied into adjacent developments.

- One bus route operates exclusively on the Transitway, while other routes start in neighborhood areas and then access the facility. Ridership levels on the system are good. For example, seven out of ten downtown workers regularly use the bus. The mode split for downtown work trips is better than most North American cities and matches some European communities. On an average weekday, some 200,000 passengers are carried on the system.

- Part of the success of the bus and transitway system in Ottawa are the "Transit First" policies of the Regional Transit Commission. These policies help ensure that land use and development activities support the transit system. For example, new regional centers must be located along the Transitway.

- The Ontario provincial government funds 75 percent of the capital elements of the system. The province also shares operating cost equally with the region, as long as OC Transpo achieves a 65 percent revenue/cost ratio.

- Stations are designed to meet local needs and passenger demands. A common design treatment—using red steel pipe and glass structures—is used throughout the system. A few large stations are tied into surrounding developments, such as a hospital and regional shopping center, while smaller stations may only have shelters and bus pull-ins.

- The backbone of bus service on the Ottawa Transitway is high-frequency service, often using articulated buses. Buses stop at all stations to pick-up and drop-off passengers. Local feeder bus routes serve most stations, allowing passengers to transfer to Transitway buses. Other routes serve local areas and then access the Transitway. Thus, during peak periods most passengers have transfer-free express service. Pedestrian walkways, and park-and-ride and kiss-and-ride facilities are also provided at many stations.

- The Transitway system has allowed OC Transpo to maintain service levels without purchasing new buses. About 145 additional buses would be needed to provide the same level of service without the Transitway.

- Other elements supporting the Transitway system include downtown bus lanes, a bus mall, and bus priority at a few selected traffic signals. In addition, many downtown employers have adopted flexible working hours and partially subsidize employee transit passes. More than 70 percent of all riders use passes. OC Transpo has also worked extensively to improve passenger information through the use of a telephone information system and video screens at some stations.

- Future plans call for the completion of the first phase of the Transitway. The 19-mile, 26-station Phase 1 system is anticipated to be completed in the near future. A Phase 2 system, which includes an additional 19 miles, is planned for the future. Eventually, tunnels will also be built in the downtown area to address growing levels of traffic congestion. OC Transpo continues to explore the use of a wide range of advanced technologies to support and enhance the system.

Provincial HOV Planning and Policies
Tom AppaRao
Ontario Ministry of Transportation

Mr. AppaRao provided a summary of HOV planning and policy activities at the provincial level. Further, he discussed some of the recent projects undertaken by the Ontario Ministry of Transportation. Mr. AppaRao covered the following topics in his presentation.

- HOV facilities are being considered in Ontario for a number of reasons. These include increasing traffic congestion, deteriorating air quality levels, environmental concerns, and declining mobility. These are similar to the reasons other areas are considering HOV projects. HOV facilities are viewed as one element of a complementary transportation solution. Further, HOV projects support the Ministry's goals relating to the efficient movement of people and goods, reducing congestion, increasing transit use, reducing energy consumption and pollution, providing cost-effective alternatives to highway expansions, and making better use of the existing infrastructure.

- In the 1970s, the first bus-only lanes opened in some cities in Ontario. The first applications focused on the peak-period use of curb lanes by buses on downtown streets. In 1989, the Ministry of Transportation began a policy study to examine the current use and potential future application of HOV facilities in Ontario. The study resulted in the adoption of policies promoting both the development of HOV projects and support for ridesharing programs. The Ministry recognizes that it will have to work with the municipalities to develop HOV facilities as part of an integrated system. Further, the need and feasibility for HOV facilities must be examined for each project to avoid the empty-lane syndrome.

- The Ministry also recognizes that a variety of supporting services, facilities, and policies must be in place to help ensure the success of HOV projects. The goal is to maximize the utilization of the highway system. An initial demonstration project is being explored for an HOV lane on the provincial highway system. In Ontario, the provincial and the municipal governments are responsible for funding the transportation elements, such as highways and transit. Currently, the Toronto area is using arterial street lanes, while Ottawa has developed a transitway system.

- Marketing and educational activities will be needed to obtain and maintain public support. Coordination with other transit and transportation modes is important. Supporting elements such as park-and-ride and park-and-pool facilities, ridematching services, and bus services are also needed to help ensure the success of HOV facilities.

- A study is currently being conducted on Highway 403 in the Toronto area. A future widening of this facility may provide an opportunity to introduce the first freeway HOV lane in the Toronto area. There may be other opportunities for future freeway HOV projects in the Toronto area also. The first phase of the Highway 403 HOV lane demonstration project is currently underway. This phase involves looking at the projected HOV volumes and the project justification. Alternative design and operational approaches are also being examined. The long-range plan for the corridor may include general purpose lanes, HOV lanes, and a separate transitway for buses.

- The Ministry has supported ridesharing activities for a number of years. The Ministry developed a commuter software program, called Share-a-Ride, and a handbook for employers to use. Funding for HOV facilities is also being examined by the Ministry.

HOV Facilities in Toronto

Tom Mulligan
Municipality of Metropolitan Toronto

Mr. Mulligan summarized the current HOV facilities in the Toronto area. In addition, he provided information on planning activities for potential future projects. He covered the following points in his presentation.

- The greater Toronto area is a very vibrant and diverse metropolitan area, which is projected to continue to grow rapidly. Metropolitan Toronto is a regional municipality comprised of six local municipalities. Metropolitan Toronto is responsible for the major regional services, including police, welfare, transit, sewer and water, and regional roads. The regional road system includes two urban expressways and the arterial street network.

- The first HOV lanes were implemented in 1972. From 1972 through 1992, HOV lanes in Toronto meant bus-only lanes. Experiences with the bus-only lanes have included successes and failures. Most of the failures focused on attempts to convert general-purpose lanes into bus lanes. As a result, between 1975 and 1990, only one new bus lane was added in the area. However, since 1990 there has been renewed interest in HOV facilities. This interest has included the opening of the first HOV lane for carpools in the area and a comprehensive HOV network study.

- Currently, there are five bus-only lanes in operation on arterial streets in the Toronto area. These include lanes in the older portions of the city and in more recently developed areas. Existing bus-only facilities are located on Bay Street, Pape Avenue, Eglinton Avenue, Allen Road, and Lansdowne Avenue. Bus-only center left turn lanes have been used with some facilities to provide improved access to subway stations and additional travel time savings for buses.

- In addition to the five bus-only lanes, one HOV lane is currently in operation and one HOV lane is in the construction stage. The Dundas Street HOV lane is open to buses, vanpools, and carpools with three or more people. A study examining the potential for a network of arterial street HOV lanes has also been undertaken. More information on the Dundas Street project and the regional study will be provided in later in the conference. The future HOV network focuses primarily on suburban areas. A rideshare strategy study is also just starting to look at what is needed to market and promote carpooling and vanpooling.

Montreal Experience with Reserved Bus Lanes

Robert Olivier
Montreal Urban Transit Society

Mr. Olivier provided an overview of the bus lanes in Montreal. He discussed the Pie IX Boulevard contraflow lane and showed a video of the facility in operation. Due to time limitations the discussion of the Park Avenue contraflow bus lane was postponed until the workshop session. Mr. Olivier did cover the following points in his presentation.

- The Pie IX Boulevard facility was the first of two arterial street bus-only lanes opened in Montreal—the Park Avenue facility was opened later. Both projects focus on the downtown area, but different approaches have been used. Both are coordinated with the subway system and other transit and transportation elements in the area.

- Before the Pie IX Boulevard HOV lane was implemented, bus operating speeds in the corridor were very slow. A number of HOV lane alternatives were examined. For example, a curb lane was considered, but it was not selected due to concerns about turning vehicles, accessibility, and other issues. Instead, the project steering committee recommended a median location for a contraflow lane. In addition, focus groups were used to obtain input from passengers and business representatives about design and operational issues.

- Buses operating on the Pie IX Boulevard HOV lane have yellow flashing arrows on the front to help alert motorists and pedestrians to the oncoming vehicles. The buses are also equipped with radios, allowing drivers to communicate with the control center, which is responsible for monitoring the project.

- The project has been successful in attracting new riders and reducing bus travel times. Currently, the lane saves some ten minutes in bus travel time. The system has been operating safely with no major accidents or problems. Survey results indicate that riders are satisfied with the service.

- The success of this project has resulted in the examination of additional bus lanes in the Montreal area. The Park Avenue contraflow bus lane, which will be discussed more extensively in a workshop session, represents one of these. The bus lane on the Champlain Bridge crossing the St. Lawrence River is another example of the use of HOV lanes in Montreal.

Round Table Discussion

Charles Fuhs, Parsons Brinckerhoff Quade & Douglas — presiding

HOV Facilities: Moving into the 21st Century

John A. Bonsall
Ottawa-Carleton Regional Transit Commission

Mr. Bonsall provided a series of observations related to the current status and future potential for rapid transit. He noted that his perspective is based largely on the experience of developing the Ottawa-Carleton busway system over the last 20 years. Mr. Bonsall covered the follow points in his presentation.

- It is important to examine the land use and development patterns that transit systems are being designed and developed to serve. For the most part, the existing land use patterns were formed around automobile travel. The development of high-capacity transit systems to serve this land use pattern must maintain the flexibility afforded by the automobile. Further, it appears inappropriate to force a high-density transit solution in a low-density area. Transfers must be reduced to attract more riders. One key of the Ottawa system has been the attempt to provide frequent and direct service from most neighborhoods to the major activity centers.

- Rather than a project-by-project approach, a systems approach needs to be applied to transit. A network of high-capacity transit corridors should be the starting point. Individual projects can then be developed within a framework. Too often, planning begins with an individual project, around which the development of a system is later attempted.

- The exact technology to be used in developing a transit system often becomes a major issue. Instead of focusing attention on a specific technology, transportation professionals should consider the potential evolution of different technologies as ridership levels and other needs warrant.

- The use of advanced technologies or IVHS represents an area that deserves, and is receiving, a good deal of attention. From a bus operator's perspective, the use of advanced technologies will help to change the whole nature of the way people perceive transit systems. The advent of improved real-time transit and traffic information can have a significant impact on the way people think about transit. Currently, the *560* system in Ottawa allows individuals to phone in their bus stop number and obtain scheduled bus information from the computer. The next logical step in this system is to provide real-time information on the status of buses. This holds the potential to provide service almost as good as offered by taxis. There are a variety of technologies that can be used to provide real-time information to individuals at their homes and places of work.

Craig Roberts
IVHS America

Mr. Roberts provided his thoughts on the use of IVHS technologies with HOV facilities and transit services. He also discussed some of the institutional issues associated with the development of IVHS. Mr. Roberts addressed the following points in his comments.

- The future of HOV facilities appears to be bright. HOV lanes offer consumers the choice to form carpools and vanpools or to use the bus in return for travel time savings and more reliable travel times. This, in turn, offers one of the best methods to increase vehicle occupancy levels. However, it is important to ensure that HOV facilities are delivering the benefits promised and that they are located in appropriate corridors. Often, HOV projects raise questions concerning public policy versus political popularity. Possible public resistance must be examined in the planning stages and appropriate techniques need to be implemented to obtain public support for the facility. Customer orientation is necessary with HOV projects.

- The movement toward better management of freeway facilities, rather than additional new construction, further supports the expanded use of HOV projects in many metropolitan areas. The flexible funding offered by many programs within the ISTEA also supports further development of HOV facilities.

- HOV projects require highway and transit agencies, and other groups, to work together to plan, design, implement, and operate the facilities. Established multi-agency working relationships are also needed for the development and operation of IVHS projects. Further, IVHS will require increased private sector participation.

- Road pricing—or congestion pricing—is another approach that is currently receiving a good deal of attention. It appears that congestion pricing holds the potential to have a dramatic impact on changing travel behavior. HOV facilities have been suggested as one way to implement congestion pricing strategies. A number of political and social issues have been raised with the use of congestion pricing, however. A greater understanding of these issues is needed before road pricing projects can be implemented effectively.

- The issue of technology serving needs versus technology for its own sake must also be addressed. It is important that the use of advanced technologies be tied to specific needs and to providing measurable benefits. The use of advanced technologies may also drive needed institutional changes, however. Thus, multiple benefits could be realized through the development and implementation of advanced technologies.

Morris Rothenberg
JHK & Associates

Mr. Rothenberg provided his thoughts on the future of HOV facilities moving toward the 21st century. He provided a brief historical perspective on the development of HOV projects and the current status of commuting as the basis for examining future directions. Mr. Rothenberg covered the following points in his presentation.

- Information from the 1990 U.S. Census and the 1990 National Personal Transportation Survey contain some disturbing trends related to the use of all HOV modes. According to these sources, the use of ridesharing is down, the use of transit has remained stable or declined slightly, and SOV use has increased. These represent national trends. Changes within a particular urban area or along a specific corridor may be different. These trends may work against the development of HOV facilities.

- There are other trends which favor the development of HOV facilities, however. For example, many provisions of recent legislation, such as the federal Clean Air Act Amendments and the ISTEA, certainly favor HOV facilities. Rather than having Congress legislate the use of HOV facilities, however, a better approach may be to try to provide a service that commuters will find valuable. Commuters want a convenient trip, they want to save time, and they want to save money. These are the basic determinants in mode choice. They have not changed significantly in the past and should not be expected to change in the future. HOV facilities that offer travel time savings and cost savings will be the most successful.

- A systems approach needs to be taken to the development of HOV facilities. A good deal of progress has been made in this regard over the past few years, but more needs to be done. HOV systems are beginning to emerge in many areas. These systems should include arterial as well as freeway HOV lanes, the supporting facilities, and the necessary supporting policies. The freeway portion, which preferably would be physically separated, represents the basic component in this systems approach. HOV systems should also be user friendly, safe to operate, and convenient for users.

- In the future it will also be important to remember that transportation planning is as much a political process as it is a technical process. In response to this, transportation planners need to become much more politically attuned. HOV projects are often controversial; transportation professionals must understand this and identify ways to address the political concerns that may arise.

- A back-to-the-basics approach is needed to ensure that future HOV projects are successful. They must be developed within a systems framework, and they must meet the basic goals of providing travel time savings, more reliable travel times, and cost savings.

Jeff Lindley
Federal Highway Administration

Mr. Lindley suggested that the projected 1,000 miles of HOV facilities by the year 2000 provided a good starting point for discussing the future vision for HOV facilities. This vision includes the HOV systems being developed in many areas, and the facilities, services, and policies needed to support them. Mr. Lindley focused his comments on the activities needed to help ensure that this vision is realized. He addressed the following points in his remarks.

- One very important issue related to future HOV projects is legislative support, especially that offered through the ISTEA. In addition, the presentations at the conference have made it clear that there is also strong support for HOV projects in Canada. The discussions have also indicated that legislative support may be too narrow of a focus and that political support is really the key. This need for political support can be framed in terms of the ISTEA, which can be viewed as an HOV-friendly piece of legislation. The credit for ensuring that many of these provisions were included in the legislation goes to many people attending the conference. However, while the political support was there to pass the legislation, that support is a very fleeting thing—as anyone from the Virginia area will remind us.

- The ISTEA provides funding authorization for a six-year period, of which the first year has been completed. Obviously, one of the things that will be looked at as planning for a new transportation bill begins in about three years is the benefits realized from the development of HOV facilities authorized in the ISTEA. Measurable benefits and results will be needed to ensure continued political support at the national level. Continued political support at the local level is also critical to the continued success of HOV projects.

- A second issue relates to both congestion pricing and the use of advanced technologies. It is important that the use of advanced technologies are tied to addressing specific problems, rather than just pursuing technology for technology's sake. Pricing appears to be an attractive approach, but becomes more difficult as the specific details of the individual projects are examined. It does appear that there is support for implementing a few demonstration projects to test this concept, however. The technology is available to make pricing work, and now may be an appropriate time to do something—the easiest way to determine if the concept will work is to try it. One of the things congestion pricing does is bring out-of-pocket costs into the mode selection decision-making process.

- A third issue involves the take-a-lane concept. In the 16 years since the Santa Monica Freeway project, the conventional wisdom has been that you cannot take an existing general-purpose lane and convert it into an HOV lane. The recent experience on the Dulles Toll Road would seem to support this reasoning. There may be situations when a general-purpose lane could be converted into an HOV lane, however. These situations need to be examined very carefully, but this may be an appropriate approach in cases where the only way to develop an HOV system is to take a general-purpose lane.

- A fourth issue relates to HOV facilities and air quality. Almost every session at this conference made reference to air quality concerns and issues. Questions are being raised by environmental groups and others concerning the air quality impacts of HOV facilities, park-and-ride lots, and other related projects. More analysis needs to be done in this area to document the air quality impacts of HOV projects.

Russ L. Pierce
Washington State Patrol

Mr. Pierce provided some ideas on the future of HOV projects from an enforcement perspective. His comments focussed on the role of the Washington State Patrol in the operation of the HOV facilities in the Seattle area and enforcement activities in general. Mr. Pierce covered the following points in his remarks.

- Enforcement agencies need to be actively involved in all phases of planning, designing, and operating HOV projects. The state patrol or a similar agency will have the ultimate authority for enforcing the facilities and ensuring their safe operation. In the Seattle area, the Washington State Patrol assigns officers to monitor and enforce the occupancy requirements during the first six months of a new HOV lane. This lets motorists know that the lanes will be enforced.

- Transportation professionals need to realize that enforcement personnel may not always understand the purpose of HOV facilities or the scope of the HOV system. Thus, planners and engineers should be sure they take the time to meet with and involve enforcement personnel in the planning and design process. This will allow enforcement agencies to conduct special training for their personnel. HOV lanes can be frustrating for enforcement staff if they are not designed accordingly. Adequate and safe enforcement areas need to be provided on HOV facilities.

- In addition to designing facilities that can be enforced safely, consideration needs to be given to ensuring that the operating requirements can be enforced. Variable occupancy rates are more difficult to enforce and keeping the operations of HOV facilities simple has a number of benefits. Not only do the enforcement personnel need to be educated, but the court system has to support citations when they are issued.

Ian Stacey
Regional Municipality of Ottawa-Carleton

Mr. Stacey provided his thoughts on the future of HOV facilities based on his experience with the development of the Ottawa Transitway system. He covered the following major points in his presentation.

- The development of HOV facilities has come a long way in the past ten years. The presentations at the conference have provided an indication of the variety of

HOV projects currently being planned, designed, implemented, and operated in North America and around the world. The major focus of HOV projects will continue to be to provide ways to maintain mobility and address environmental concerns.

- Although HOV projects may differ, they are all based on moving more people more efficiently and keeping urban areas liveable. It is also important to remember, however, that there is no single universal solution and that HOV facilities may not always be the correct approach. Many approaches will be needed to address the numerous problems facing urban areas today.

- Political support is needed to develop and operate HOV facilities. This point, and the importance of public acceptability and support, should not be forgotten. Even in areas with successful HOV projects, the ongoing support of all groups is needed. It is also important to learn from projects that may not have been successful and to continue to try new ideas and projects.

- There does appear to be a heightened awareness about environmental issues in both the United States and Canada. This provides an opportunity to advance transit, HOV facilities, and other projects. This may involve taking risks sometimes, but change does not often come without taking risks.

Alan Gonseth
Champagne Associates

Mr. Gonseth provided an overview of the recent activities of the Institute of Transportation Engineers (ITE) related to HOV projects. His summary included a description of the following projects.

- The use of HOV facilities is highlighted as one of the key approaches to managing congestion and improving air quality in the ITE publication *A Toolbox for Alleviating Traffic Congestion*. This document is geared toward local elected officials, although it is also a good reference for engineers and planners. Over 40 different articles related to HOV facilities have been published in the *ITE Journal* and additional articles are always welcome.

- ITE has also been asked by FTA and FHWA to develop travel demand management (TDM) seminars and videotapes. HOV facilities have been included in these materials. ITE is further in the process of initiating a TDM Task Force. HOV facilities will be within the scope of this task force, which could potentially develop into an ITE council. This task force can also assist in confronting many of myths and fears associated with HOV projects. Educating the public and local elected officials is very important in this regard.

- A monograph on the benefits of HOV facilities is being prepared by ITE. This monograph, which should be available early in 1993, focuses on providing information on HOV projects to policy makers and the media.

Closing Session

John A. Bonsall, Ottawa-Carleton Regional Transit Commission — presiding

TRB HOV Systems Committee Activities

Donald G. Capelle
Chairman, TRB HOV Systems Committee
Parsons Brinckerhoff Quade & Douglas

I would like to close the conference by covering a few highlights from the last three days. I also want to provide an overview of the activities of the TRB HOV Systems Committee over the past year. The committee continues to be one of the more active TRB committees and it continues to be a challenge to respond to the enthusiasm of the committee members.

I have been extremely impressed with the conference and with Ottawa. We all have learned a great deal from the information and exchange of ideas at the different sessions and from seeing the Ottawa Transitway system in operation. The National Conferences on HOV Systems continue to attract a diverse group of people—this year we have people from as far away as Saudi Arabia, Madrid, and Taiwan, and we are looking forward to attracting an even more diverse group at our next conference now being planned for Los Angeles in the spring of 1994.

Viewing the Ottawa Transitway system reinforced the important role buses play in HOV projects. This underscores the need to continue to focus on the most effective way to move people in our urban areas. Buses, vanpools, and carpools all contribute to improving mobility and reducing congestion levels in major urban travel corridors.

We have also heard about the potential of increased funding for HOV facilities through the various sections of the ISTEA and other state and local programs. Although it appears that additional funding may be available in the future, transportation professionals need to ensure that these funds are wisely allocated. HOV facilities may not be appropriate in all corridors or in all areas. HOV facilities should continue to be planned, designed, and operated to address specific problems.

Recent experience further indicates the need to expand education and training programs related to HOV facilities. These programs should focus not only on the technical needs of transportation professionals, but also providing relevant information to policy makers. All groups will benefit from an enhanced understanding of the benefits of HOV facilities.

The workshop sessions on bus services, supporting facilities and programs, TDM strategies, and other elements continued to stress that HOV facilities by themselves may not be totally successful. HOV projects must be viewed as one part of a comprehensive package that includes a full range of components. HOV lanes provide the critical line-haul link, but other facilities, services, and programs are needed to help ensure success.

The workshop sessions also stressed the need for the ongoing monitoring and evaluation of HOV projects. Information on the status and effectiveness of the different projects is critical for both local and national policy makers. Other important topics discussed at the conference included the air quality impacts of HOV facilities, arterial street HOV projects, and the use of advanced technologies. More research and studies are needed in many of these areas as well, and the committee is currently working on the development of a comprehensive HOV research program.

We have all benefitted from this exchange of information and I hope that you will take the information presented here and share it with others back home. This will help to expand the understanding of the issues associated with HOV facilities.

I would now like to highlight a few of the activities the TRB HOV Systems Committee has undertaken over the past year. The committee continues to be one of the more active TRB committees. Committee membership is limited by TRB to just 25 individuals, but we have more than 35 friends of the committee who contribute significantly to the committee's activities. There is no limit on the number of friends of the committee we can have, so I would encourage any of you who might be interested to sign up as a friend and help foster the development of the committee activities.

The HOV Systems Committee was the first TRB committee to develop a strategic plan, and this year we completed an update of the plan. This plan outlines the activities and objectives of the committee and provides a schedule as to how we plan to meet those objectives.

The committee has also focused a lot of effort on providing information on HOV facilities and helping to coordinate the sharing of information between diverse groups. Conferences such as this represent one of the major activities of the committee. Another activity has been the publication of a quarterly newsletter on HOV projects around the world. This has been developed under the leadership of Tim Lomax.

The HOV Systems Committee is organized into four basic subcommittees. The Information Development and Dissemination Subcommittee is responsible for organizing the international conferences, the sessions at the TRB Annual Meetings, and developing informational material on HOV projects. This group has been very active under the leadership of Katie Turnbull.

The Research, Planning, Design, and Operations Subcommittee is chaired by Adolf May. This subcommittee is responsible for identifying research needs and developing problem statements for consideration by different funding sources. This subcommittee has been very active and you will be hearing more about their recent efforts in upcoming publications.

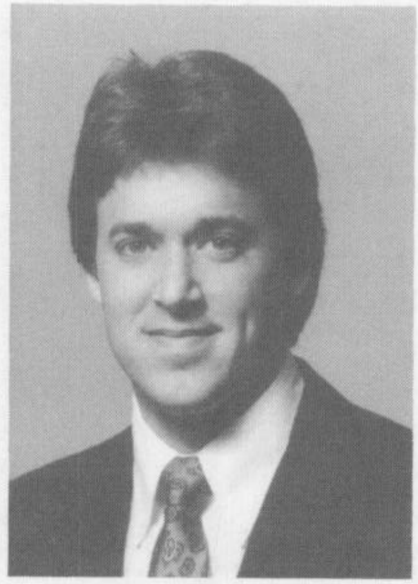
Bo Strickland is Chairman of the Marketing/Outreach Subcommittee. This group has been exploring the development of a marketing training brochure for use in areas implementing HOV projects. This subcommittee is also exploring potential ways to enhance international outreach activities and to provide information to policy makers who make decisions on the implementation of HOV facilities.

Finally the Strategic Planning Subcommittee is chaired by Chuck Fuhs. As I mentioned earlier, this subcommittee has just completed an update of the committee's Strategic Plan. It is also responsible for coordinating the committee's activities with those of other professional organizations.

In closing, I would like to thank John Bonsall who served as Chairman of the conference. John and his staff did an excellent job in organizing all the tours and activities during the conference, and in recognition of his hard work, I would like to present John with a plaque from the TRB HOV Systems Committee thanking him for his assistance. Katie Turnbull also did a great job as Chairperson of the Technical Program Committee and her efforts deserve notice. Rich Cunard, Angela Arrington, Reggie Gillum, and Catha Stewart from TRB have also done an outstanding job in arranging the hotel and conference accommodations.

HOV Facility Research Topics

Russell Henk
Texas Transportation Institute



The Research, Planning, Design, and Operations Subcommittee met on Monday evening to discuss research needs related to HOV facilities. It was a very lively meeting and a number of good research topics were identified. The suggested topics have been grouped into three categories: planning and design, operations and enforcement, and arterial street HOV facilities. A number of specific topics were identified within each of those broad categories.

Within the planning and design category, topics suggested included connecting HOV facilities and HOV system planning, implementing HOV lanes in rail corridors, and HOV user trip purposes. Suggested research topics in the operations and enforcement category included examining the potential use of advanced technologies to assist with HOV enforcement, examining the cost-effectiveness of 24-hour versus peak-period HOV operation, analyzing time-series data, and examining lower-technology approaches to enforcement. Topics included in the arterial street HOV category included a state-of-the-art review of current experiences and projects, developing evaluation criteria, and identifying guidelines for arterial street HOV facilities.

Members of the subcommittee and others will be developing problem statements for each of these topics. The subcommittee will also identify possible funding sources for each of the research problem statements. The problem statements will be reviewed by the full HOV Systems Committee in January. Based on this review, the topics will be finalized and submitted to the different funding sources through the appropriate channels.

1994 HOV Conference
David Barnhart
Los Angeles County Transportation Commission

On behalf of the Los Angeles County Transportation Commission I would like to invite you to attend the 1994 International Conference on HOV Systems in Los Angeles. There are a number of exciting projects currently underway in Southern California involving numerous agencies and jurisdictions. For example, some 600 lane-miles of freeway HOV facilities are being planned in Los Angeles County alone, along with a full traffic management system.

We plan to focus the conference around many of the activities underway in Southern California. Keynote speakers, workshops, and technical tours will all be part of the conference. A variety of technical tours may be offered in addition to a tour of the local HOV facilities.

A local planning group is being organized and will be working closely with the TRB HOV Systems Committee to plan the different elements of the conference. I welcome any suggestions on topics or technical tours that you would like to see included. I hope you will be able to join us in Los Angeles in 1994!

CONFERENCE WORKSHOPS

Ottawa,
Ontario, Canada

Moving into the 21st Century

Bus Service Orientation with HOV Facilities

James R. Lightbody, Santa Clara County Transportation Authority — presiding

The Ottawa Experience

Doug McCorquodale
Ottawa-Carleton Regional Transit Commission

Doug McCorquodale provided an overview of the HOV facilities in the Ottawa area. He noted that there are five types of HOV lanes in operation in the area. These are the bus mall, the curb bus lanes, the Fast Acting Lanes, the shoulder bus lanes on the freeways, and the Transitway. Mr. McCorquodale described the following points associated with these facilities.

- The Regal Bus Mall is approximately one-quarter mile long. It is open to buses and taxis from 6:00 a.m. to 6:00 p.m. on weekdays and is open to all traffic on weekends. Dynamic signing is used at the entrance to control traffic. Approximately 45,000 transit passengers move through the Regal Bus Mall on a daily basis. During the peak hour, about 150 buses operate in each direction on the mall.

- Currently, the mall has one lane in each direction and a center passing lane. In the next year, an additional lane will be added in each direction for mixed traffic. In addition, other modifications will be made to the sidewalks and passenger waiting areas to improve the visibility to stores and help revitalize the area.

- Curb bus lanes are used in a number of locations throughout the area. Approximately two miles of curb lanes are in operation on arterial streets in suburban areas. The lanes are reserved for bus use during the morning and afternoon peak periods. Parking is permitted in the curb lanes during other times of the day. The lanes help maintain bus speeds and bus travel times during the congested peak periods. Enforcement of the curb lanes can be a problem, but experience indicates they do provide important benefits.

- In the downtown Ottawa area, the second lane from the curb is used as the bus lane. These are called "Fast Acting Lanes" and are in operation on two parallel one-way streets. Approximately 1½ miles of Fast Acting Lanes are in operation in downtown Ottawa. The use of the second lane leaves the curb lane open for buses to pick-up and drop-off passengers, as well as other uses. Approximately 180 to 200 buses use the Fast Acting Lanes in the peak hour.

- The Fast Acting Lanes connect to the Transitway at each end of the downtown area. Currently, the lanes are operating close to capacity during the peak hours. As a result, delays can occur due to weather, emergencies, and traffic accidents. Future plans call for a bus tunnel through the downtown area to replace the Fast Acting Lanes. Currently, synchronized traffic signals and other additional priority measures are being used to maintain bus travel speeds through the downtown area. Also, the use of advanced bus arrival signs, which would provide real-time information on the status of the buses from the AVL system, is currently being explored.

- Currently, a one-mile freeway shoulder lane is being used as a bus lane and an additional five miles will be officially opened this week. The lanes are located on the paved shoulder of Highway 17 and operate only in the inbound direction in the morning peak period. The lane will provide additional travel time savings for buses operating from an eastern suburb, and connects to the Transitway about six miles from the downtown area. Buses will travel through the interchanges using the off-ramps.

- The Transitway provides the major backbone for the bus system in Ottawa. Currently, 13 miles of the two-lane bus-only facility are open. The system includes 17 stations at the present time. At stations, passing lanes are provided to allow independent movements for buses. Many stations also include bus transfer areas and access to the local street system. The Transitway carries approximately 9,000 passengers per hour at the maximum load point. Bus operating speeds are high and travel time reliability is very good.

- This combination of different types of HOV lanes has proved to be very successful in the Ottawa area. Buses are able to maintain relatively high travel speeds and the reliability of the service is good. A variety of improvements and expansions are being planned and implemented to further enhance the overall system.

The Pittsburgh Experience
David Veights
Port Authority of Allegheny County

David Veights provided an overview of the transit and HOV systems in the Pittsburgh area. He noted that a multimodal approach has been taken to addressing transportation needs in the area. Transit elements of the transportation system include HOV lanes, busways, LRT, and an incline railway. Mr. Veights discussed the following aspects relating to transit and the HOV system in the Pittsburgh area.

- The population of Pittsburgh is approximately 376,000 and the population of Allegheny County is about 1.2 million. The economic base of the region has changed from industrial to primarily service industries. The downtown area, which covers about 400 acres, has an employment base of approximately 140,000 people. The geography of the area presents a number of limiting factors for the transportation system.

- The bus system in Pittsburgh carries approximately 75 million passengers a year and the LRT system carries some 8 million annual passengers. A 10.5-mile segment of the LRT system was reconstructed in 1987. Pittsburgh was one of the first cities to implement a paratransit system. Currently, this system carries about two million passengers a year. An incline railway is also in operation in the city, carrying some one million annual riders.

- The first HOV lanes in the area were concurrent flow bus lanes in downtown Pittsburgh. Implemented in 1977, the lanes allowed buses to move through the downtown area faster. Additional contraflow lanes were implemented on streets approaching the downtown area and in the area towards the University of Pittsburgh.

- The South Busway was opened in 1977. It is about four miles long, and was constructed at a cost of approximately $27 million. Some 15,000 passengers use the facility on a daily basis. The busway has helped alleviate congestion on Route 51, the road previously used by the buses. The busway has two 14-foot travel lanes and curbs, but no shoulders. The South Busway shares right-of-way with the LRT system approaching the downtown area. This includes the joint use of the Mount Washington Tunnel by both buses and light rail vehicles. The South Busway provides buses with 15-minute travel time savings from the previous service on Route 51.

- The Martin Luther King (MLK) East Busway was opened in 1983. Construction costs were approximately $113 million, of which some $20 million was used to relocate a segment of existing railroad tracks. The busway was constructed in the right-of-way of an operational railroad line. Depending on the trip, the East Busway has reduced travel times for buses in the corridor from 20 to 30 minutes. A trip that used to take 40 minutes, now takes only 10 minutes.

- The MLK East Busway carries approximately 31,000 passengers a day. Two types of services are operated on the busway. One is buses that operate only on the busway. These function much like fixed-guideway transit, providing frequent service along the busway. Other buses provide service to neighborhood areas and then access the busway for the trip downtown. Connections are provided to the bus lanes in the downtown to further provide priority to buses.

- Busway station areas have four lanes to allow buses to pass each other as they stop to pick-up and drop-off passengers. The stations were designed to tie into the surrounding areas and the facilities are well-maintained.

- Plans are currently underway to build a new busway to the airport. A variety of alternatives were examined for the facility, but it appears that a seven-mile busway is the preferred alternative. In addition, an extension to the MLK East Busway is being considered along with other improvements.

The Community Transit Experience
Larry Ingalls
Community Transit

Larry Ingalls discussed the types of services developed and operated by Community Transit using the HOV lanes in the Seattle area. Community Transit provides bus service in Snohomish County, which is to the north of Seattle. Mr. Ingalls covered the following points in his presentation.

- Community Transit operates 180 buses, with 90 used for commuter service. Most of that service is focused on downtown Seattle and the University of Washington. Those buses use the I-5 North HOV lanes. Community Transit coordinates its services and activities with Seattle Metro, the ferry system, and the Washington State Department of Transportation. A number of major employers are located in the county and Boeing has plans to expand their facilities and add 10,000 employees over the next three years. Vanpools are also used in the area, and appear to be a viable approach to meet the diverse travel patterns of many employees.

- A total of approximately 3,000 spaces are provided at park-and-ride lots in Snohomish County. By 1998, a total of 6,000 spaces should be added to the system. Many of the existing lots are being used to their capacity, so the additional space is needed to accommodate growth in the system.

- Community Transit uses a transit center in downtown Everett and operates some service to the transit center in Bellevue. Because of the need to use diesel and electric dual-powered buses, Community Transit does not operate in the downtown Seattle bus tunnel.

- A variety of types of HOV lanes are in operation in the Seattle area. These include concurrent flow HOV facilities on both the inside and outside lanes, exclusive barrier-separated HOV lanes, and arterial street HOV lanes. Community Transit buses use the I-5 North concurrent flow HOV lanes on routes oriented to downtown Seattle and the University of Washington.

- A demonstration project was implemented on the I-5 North HOV lanes in August 1991 lowering the vehicle occupancy requirement from three persons per vehicle (3+) to two persons per vehicle (2+). This change resulted in an increase in the number of vehicles using the HOV lanes. Volumes in the peak hour have increased from 400-500 vehicles to 1,200-1,400 vehicles. The travel times and on-time performance of Community Transit buses have not changed much in the morning in-bound direction, but problems have been noticed in the outbound direction. It appears that the 3+ requirement may be reinstated for the outbound direction in the afternoon.

- The current HOV system could be improved with more direct access to the lanes. Although enforcement has generally been good in the Seattle area, additional enforcement in some areas may be warranted. Providing adequate enforcement areas is also important. The use of advanced technologies may help enhance enforcement efforts.

- Community Transit has experienced a steady growth in ridership. With the projected growth in population and employment, service expansion will be needed in the future. A current study is examining the potential for arterial street HOV applications in Snohomish County, and other service improvements are being considered.

HOV Facility Design Guidelines

Jim Robinson, Federal Highway Administration — presiding

AASHTO Standards

Charles Fuhs
Parsons Brinckerhoff Quade & Douglas

Mr. Fuhs summarized the newly released HOV standards developed by the American Association of State Highway and Transportation Officials (AASHTO). He covered the following points in his presentation.

- AASHTO has been involved for a number of years in supporting the dissemination of information on HOV facilities. In 1983, AASHTO published a set of guidelines on HOV and public transit facilities. This report was well received and was used as a reference on HOV facilities by many transportation professionals. It was based on the experience with the HOV facilities in operation at that time, however. As experience was gained with new projects, it became obvious that this guide needed to be updated.

- A task force was formed, comprised of individuals with diverse backgrounds, by AASHTO to under take the process of developing a new guide to HOV facility planning and design. The task force coordinated their activities with FHWA, FTA, the TRB HOV Systems Committee, and with the development of HOV manuals in California, Texas, and other states.

- The AASHTO report incudes sections on HOV planning, design, and operational considerations. The detail included in these sections represent significant improvements over the previous report. A comprehensive discussion is provided on different HOV treatments and issues to be considered in planning, designing, and operating HOV projects. As reflected in the title, the design treatments for different types of HOV facilities are outlined in detail in the report. A number of examples are provided on different HOV design treatments. The use of minimum design standards is also discussed.

- All types of HOV lanes are included, along with queue bypass lanes and metered freeway entrance ramps. The different types of access and egress are also presented. Enforcement issues are discussed and design treatments for enforcement areas are presented. HOV signing is reviewed, with emphasis on guide signing.

- The guide clearly places more emphasis on planning. It also notes that meeting full design standards is not always possible and that exceptions may have to be made in some cases. It also recognizes that the HOV facilities must meet local needs.

- A companion document was also issued by AASHTO at the same time. This report, *Park-and-Ride Facility Guidelines*, focuses on planning and design guidelines for park-and-ride lots. Like the HOV report, this document contains a number of layouts and scenarios for different types of park-and-ride facilities.

ITE Guidelines

Tim Lomax
Texas Transportation Institute

Dr. Lomax provided an overview of the recent activities of the Institute of Transportation Engineers (ITE) related to HOV facilities. An ITE committee has just completed a report on HOV design features. Dr. Lomax addressed the following points related to the report, which is available through ITE.

- A number of different references are available on HOV facility design treatments. The ITE publication was put together to provide information on current practices. It includes a discussion of both desirable and reduced standards for different types of HOV facilities.

- The discussion of mainline HOV design treatments includes reversible, barrier-separated HOV lanes; two-way HOV lanes; buffer separated facilities; left- and right-hand side concurrent flow HOV lanes; and contraflow HOV lanes. Desirable and reduced standards are provided for each of these. Busways are not examined in great detail, but are included. Queue bypass treatments are also addressed.

- The document steps through the different elements that should be considered in the design process. This provides an enhanced understanding of the advantages and limitations of different approaches. Thus, the report outlines the factors that should be considered if compromises must be made in desirable design standards.

- Enforcement areas and activities are addressed for the different types of HOV projects. Addressing enforcement issues during the planning and design process is stressed. It is important to involve enforcement personnel early in this process.

- The state-of-the-practice relating to access and egress design is covered in the report. The different types of direct access connections and at-grade connections are also described. The advantages and limitations of the different treatments are discussed, along with design guidelines.

- The committee was not able to address a number of important issue, however. The document outlines these for future consideration. Safety concerns, buffer widths, arterial street HOV facilities, buffer versus barrier separation, HOV signing, and the use of the moveable barriers represent just a few of these issues.

Operational Issues Related to Design
Mike Delsey
IBI Group

Mr. Delsey provided a summary of the Highway 417 study conducted for the Ontario Ministry of Transportation. Many of his comments focused on the operational issues related to different HOV design alternatives. Mr. Delsey covered the following points in his presentation.

- The study involved examining the projected growth in demand in the highway 417 corridor and different alternatives to meet this demand. The corridor includes both well developed areas, suburban areas, and green space areas. Traffic congestion is a problem in the corridor during the peak periods.

- A number of different alternatives were examined. These included traditional approaches such as adding general-purpose lanes. Other alternatives included reversible general-purpose lanes, HOV lanes, a shoulder bus lane, and a traffic management system.

- The analysis of the HOV lane options focused on travel time, throughput, cost-effectiveness, and geometric issues associated with the different types of HOV facilities. The lane and route continuity through the project was examined, along with concurrent versus contraflow HOV lanes. The concurrent design was the favored alternative from a safety and operations perspective. The frequency of interchanges was considered in the analysis of inside versus outside HOV lanes. For a long distance HOV operation, inside operation is preferable, especially with large volumes of vehicles entering and exiting the freeway at closely spaced intersections. An outside lane may provide better bus access, however.

- The outcome of the HOV analysis indicated that the HOV lane would be limited to a relatively short section. Operation during the peak period only was suggested at a 3+ vehicle occupancy requirement. The study also pointed out that the benefits of such a facility could be increased greatly if it was part of a regional HOV system.

- In order to provide some immediate help to the OC Transpo buses operating in a portion of the corridor, a shoulder bus lane was developed. A number of design issues were considered in the development of this facility. The lane will be operated only in the morning peak period. The shoulder bus lane will open this Wednesday morning.

Efficient Utilization of HOV Facilities

Jeff Lindley, Federal Highway Administration — presiding

Taking a General-Purpose Lane for HOV Use

Paul Jovanis
University of California-Davis

Dr. Jovanis provided a summary of a current research project underway at the University of California-Davis. The study, which is funded by the California Department of Transportation and the California Air Resources Board, is examining public attitudes toward the conversion of general-purpose traffic lanes to HOV lanes. Dr. Jovanis covered the following points in his presentation.

- The research study focuses on identifying potential public reactions to taking a general-purpose freeway lane for use as an HOV lane. The goal of the project is to investigate public perceptions, attitudes, and behavior toward the conversion of an existing lane into an HOV lane. Ideally, the study will try to identify the circumstances and situations under which the public would support conversion of an existing lane. The products of the study should be of use in marketing and public information campaigns associated with HOV projects.

- The research approach started with a review of available literature. In addition to examining the traditional research reports, an extensive review was made of newspaper articles and other literature to help identify public response to past and current HOV projects. The Santa Monica Diamond Lane is really the only experience to date with taking a freeway lane for HOV use. The public response on this project is well known. The general issues associated with HOV projects identified in the literature review included safety concerns, enforcement, the empty lane syndrome, and the fairness or equity issue.

- The literature review also indicated that HOV lanes alone may not always be a strong enough incentive for ridesharing. Other issues, such as the cost of commuting and scheduling difficulties are also important considerations in mode choice decision. It is also not clear if the public has different perceptions related to various types of HOV facilities.

- Two focus groups were conducted to obtain additional insight into the perceptions of the public. One of the focus groups was comprised of bus riders, carpoolers, and vanpoolers who use the San Bernardino Freeway Busway. The second group consisted of motorists who drive alone in the same corridor. Additional focus groups will be conducted in Northern California.

- The preliminary results from the two focus groups provide some interesting insights into the perceptions of HOV lane users and motorists in the general-purpose lanes. These two groups agreed on a number of topics. Both focus groups identified similar motivations for sharing rides. Saving money and employer support of ridesharing activities were rated highest by both groups. The presence of an HOV lane in the corridor was identified as important, but not as high as the first two incentives. Further, both groups identified schedule and time demands as the key reasons for not ridesharing. Some carpoolers noted that meeting rideshare schedules was sometimes a problem. The non-rideshare focus group participants also indicated a lack of interest in obtaining more information on ridesharing.

- A number of questions focused specifically on HOV facilities. Both groups seemed to understand the costs and impacts associated with new freeway construction, the addition of different types of HOV lanes, and the possible conversion of an existing lane into an HOV lane. The alternative of converting an existing lane seemed to have the least support among all the options. However, this alternative was supported when tied into existing or planned HOV facilities. There did not appear to be a clear perception or understanding among either group of the concept of opportunity costs.

- Most of the non-HOV users supported the idea that HOV users be given priority. Thus, they felt that people should receive some benefit from sharing rides. However, this group was also vocal that the HOV lane should be well utilized. An unused facility was equated to government inefficiency and participants indicated they would be less favorable toward a facility that was not well utilized. Thus, people clearly tied utilization levels to the success or lack of success of a facility.

- Conversion of an existing lane was discussed along with other options such as road pricing and TDM strategies. Road pricing and odd/even day driving elicited very strong opposition.

- HOV lane users were very concerned about the potential safety and operating issues associated with converting a general-purpose lane. One suggestion from this group was to tie the promotion of HOV facilities to supporting the local economy and helping businesses stay in the Los Angeles area.

- The next phases of the study include conducting focus groups in Northern California, business surveys, and public surveys. These should be completed by June 1993 and more information on the project will be available by the 1994 TRB Annual Meeting.

Congestion Pricing with HOV Lanes
Dennis L. Christiansen
Texas Transportation Institute

Dr. Christiansen provided an overview of the potential testing of congestion pricing with HOV facilities. He used the Houston HOV lanes to illustrate how one demonstration might be developed. Dr. Christiansen covered the following points in his presentation.

- Congestion pricing has been discussed for many years, but the concept has not really been tested in the United states. Advances in technologies and growing traffic congestion have resulted in more serious consideration of the concept in some metropolitan areas. Houston is one area where the potential of a congestion pricing demonstration has been discussed recently.

- Reasons for considering congestion pricing include the inability to build new facilities, a lack of funding, and the generation of new revenue. Further, congestion pricing represents one way to allocate supply and demand.

- The primary purpose of HOV lanes is to increase the effective capacity of the roadway system for moving people. Thus, the goal of HOV facilities is to increase average vehicle occupancy levels. If this is accomplished, it will have positive impacts on congestion levels, air quality, and energy consumption.

- There are a number of issues associated with the use of congestion pricing. Most of these revolve around social-equity concerns, rather than technology issues. Congestion pricing is viewed by some as favoring the rich—who can afford to pay—and hurting the lower income groups who cannot. There is some thought that issues like this can be addressed.

- The ISTEA provides funding for congestion pricing demonstration projects. If congestion pricing does make sense, a logical place to test the concept may be in a barrier-separated HOV lane. This provides a well-controlled environment, with limited access, that would be ideally suited for a demonstration project.

- Preliminary discussions in Houston have focused on the potential of implementing a congestion pricing demonstration project on one of the HOV lanes. Such a demonstration could focus on a number of objectives. First, pricing would be used to make it more attractive to use an HOV commute mode. Operations and enforcement of HOV lanes represent a significant cost. It might be possible to reduce some of these costs through the use of toll tags or other devices implemented as part of a congestion pricing demonstration. A second objective would be to maximize the use of the HOV lane. It appears the Houston HOV lanes can move approximately 1,500 vehicles per hour in a safe, fast, and reliable manner. However, these volumes are very rarely reached. Congestion pricing may be able to help ensure higher use of HOV lanes and avoid the perception that they are under-utilized.

- Congestion pricing represents one possible approach to managing demand on HOV lanes. Some facilities are congested using a 2+ vehicle occupancy requirement, but have too few vehicles at a 3+ requirement. Further, congestion pricing could generate additional revenues and reduce the costs associated with enforcement and operation.

- A congestion pricing demonstration on an HOV lane could include either static pricing or real-time pricing. Traffic management systems provide a wealth of information that could be used for a real-time pricing demonstration. For example, the information available from a traffic management system could be used to determine the travel time savings offered by the HOV lane depending on the level of congestion in the general-purpose lanes. It could also tell the unused capacity available in the HOV lane. These two factors could be used to price the use of an HOV facility by different vehicles. Dynamic signing and other technologies could be used to communicate the authorized users and the charges to motorists.

- A substantial revenue stream could be generated through a congestion pricing demonstration. If the objectives were to increase average vehicle occupancies and reduce operating and enforcement costs, this revenue could be used to pay for operation and enforcement, subsidize bus services, and support ridesharing programs.

- One approach to a possible demonstration would be to allow 3+ carpools and vanpools to use the lanes at no cost during all times of the day. This would create an incentive to create 3+ carpools. Bus fares could be reduced, providing additional incentives to ride the bus. Both of these create financial incentives to use a high-occupancy commute mode. During the peak hour, 2+ carpools would be allowed to use the lane for a price. The toll would be established so that the capacity of the lane would not be exceeded. Outside of the peak hour, 2+ HOVs could use the HOV lane at no cost, and single-occupant vehicles would be allowed to use the facility, again with the toll set to keep volumes below the capacity of the lane. It appears that such an approach is feasible and would have multiple benefits for all user groups and agencies.

Congestion Pricing Demonstration
David Schumacher
Metropolitan Transit Development Board

Mr. Schumacher provided a summary of a proposed congestion pricing demonstration project in the San Diego area. The demonstration project focuses on the I-15 HOV lanes. Mr. Schumacher covered the following points in his presentation.

- The concept behind the demonstration focuses on allowing single-occupant vehicles to use the spare capacity on the HOV facility for a price. The FTA recently awarded a $350,000 grant to the San Diego Council of Governments (SANDAG) for a study of the concept. In addition to SANDAG and FTA, the study is being conducted by Caltrans and FHWA.

- The project focuses on the eight-mile, two-lane, reversible, barrier separated I-15 HOV facility. The lanes were opened in 1988 and utilize a 2+ vehicle occupancy requirement. The facility does not have any intermediate access points. It is open to buses, vanpools, and carpools with two or more persons, and motorcycles. It is open only during the morning and afternoon peak periods. Although use of the facility has increased, it is still considered under-utilized for much of the peak period.

- There is a perception that the facility is under-utilized, although most commuters feel it has improved traffic flow in the general-purpose lanes. The SANDAG study, which is anticipated to begin in early 1993, is really a feasibility analysis. The study will examine the feasibility of the overall congestion pricing concept to ensure that it is worth pursuing. If it is determined that the concept is worth testing, the next step will be to design a demonstration project. The demonstration would then be implemented and evaluated.

- The study will be conducted in two phases. The first will assess the feasibility of a low-technology pricing mechanism. This might focus on some type of a pre-paid permit system. The long-term objective would be to examine advanced technology applications. Each phase will examine a number of pricing and operating alternatives. The study will also analyze future HOV demand and excess capacity in the HOV lane. The study is just a feasibility analysis, so there is still a long way to go before any project would be implemented.

Integrated Systems and Support Facilities

Donald J. Emerson, Federal Transit Administration — presiding

The Houston HOV Lane System

Stephen Albert
Metropolitan Transit Authority of Harris County

Stephen Albert provided a summary of the different elements of the Houston HOV lane system. The I-45 North contraflow lane, which started as a demonstration project 12 years ago, was the first example of a freeway HOV lane in the area. Today, some 47 miles of a planned 96-mile system are in operation. Mr. Albert covered the following points in his presentation.

- The HOV lane system in Houston incudes the HOV lanes, direct access ramps, park-and-ride lots, transit centers, express bus services, and a surveillance, communication, and control system.

- The HOV lane system has been jointly developed and operated by the Metropolitan Transit Authority of Harris County and the Texas Department of Transportation. An ongoing monitoring and evaluation program is being conducted by the Texas Transportation Institute.

- The Houston HOV lanes are reversible, one-lane, barrier-separated facilities located in freeway medians. HOV lanes are currently in operation on four radial freeways. A fifth HOV lane will be opening next year and another is in the planning stage.

- Direct access ramps from many park-and-ride facilities are provided, which yield additional travel time savings to HOVs. A number of large park-and-ride lots have been developed as part of the HOV lane system, many with space for over 1,000 vehicles. Overall, 22 park-and-ride lots provide some 18,000 parking spaces. New premium express bus service has been implemented from these lots. In addition, the lots are used by commuters as carpool staging areas.

- Several transit centers are also being developed. They will be convenient transfer locations for cross-town, radial, and local routes. The transit centers are focal points for the development of the Regional Bus Plan.

- A variety of IVHS technologies are being studied for application in the Houston area. Many of these focus on the HOV lanes. In addition, a surveillance, communication, and control system is being developed that will include the HOV lanes.

Seattle HOV Facilities

Les Jacobson
Washington State Department of Transportation

Les Jacobson provided an overview of the various facilities, services, and policies supporting the HOV lane system in the Seattle area. Mr. Jacobson discussed the following elements of the overall HOV system.

- An extensive system of park-and-ride lots are being developed to help support the HOV lanes. Currently, some 128 lots are in use, providing approximately 20,200 parking spaces. Additional facilities are being planned. Support services, such as convenience stores and day care facilities, are being considered for possible incorporation with future park-and-ride lots. Security is provided at most of the lots, but vandalism can sometimes be a problem in certain areas.

- Bypass lanes for HOVs at freeway entrance ramp meters are also provided in some areas. Almost all new metered ramps have HOV bypass lanes. Freeway flyer bus stops or on-line bus stations are used in some areas to allow buses to pick-up and drop-off passengers without having to exit the freeway. Off-line transit stations have also been developed to enhance transferring between services and to act as collection points.

- A number of policies supporting the use of HOVs have been enacted at the state and local levels. For example, a number of areas have implemented transportation demand management (TDM) programs. TDM and HOV represent complementary efforts. One suburban community undertook an aggressive TDM program, which has resulted in an increase in the use of HOVs from 15 percent to 50 percent of commuter work trips.

- The Washington State Legislature recently passed the Commute Trip Reduction Law. The purpose of this legislation was to reduce the amount of single-occupant commuting and to encourage greater use of all forms of HOVs. The legislation targets specific market groups for the trip reduction programs, with the major focus on employment sites with more than 100 employees. A target has been set to reduce vehicle-miles of travel from these sites by 15 percent in 1995, by 25 percent in 1997, and by 35 percent in 1999. A state task force is currently working on the implementation program for the legislation.

- A study in the Puget Sound region, called *Vision 2020*, examined a variety of issues related to the future development of the area. The study examined land use, transportation, and other issues. The need to provide land use and development patterns that are more accessible to transit was noted in the study. It also examined policies to increase land use densities in some areas. Higher densities tend to be more supportive of increased transit use. Parking policies and parking pricing levels can also be used to influence greater use of transit. There are numerous institutional issues that need to be addressed in examining changes in land use and parking policies.

- A number of other services are also used to support the HOV lanes. These include the enforcement program, the HERO program, expanded and new bus services, marketing, rideshare matching services, and the monitoring program. In addition, a number of new technologies are being examined to enhance many aspects of the transportation system, including the HOV lanes. The *Traffic Reporter* system, which provides computerized information on current traffic conditions, is one example of this.

- Arterial street HOV lanes are currently in use in a few areas and more are being planned. The ferry system also incorporates incentives for HOVs through priority loading of carpools and vanpools. Some people combine the ferry system and bus service to get to their destination. Thus, the multimodal aspects of transportation in the Seattle area are very important.

The Santa Clara County HOV Lane System
James R. Lightbody
Santa Clara County

Jim Lightbody provided an overview of the development and current status of the HOV lane system in Santa Clara County, California. He covered the following major points in his presentation.

- Santa Clara County, which is located in the San Francisco Bay Area, has an employment base of approximately 800,000 people. There is no major downtown area, however. Rather, employment is dispersed throughout the county. As a result of this development pattern, congestion occurs on many roadways throughout the county. The HOV lane network was developed to help respond to traffic congestion on different segments of the roadway system.

- The Santa Clara Transportation Authority, which is part of the county government and operates the transit system in the area, has adopted a multimodal approach to deal with the growing transportation problems. The authority manages and operates the county expressway system, a fleet of 500 buses, and the light rail transit (LRT) system. The first HOV lane was opened in 1982 and there are now 60 miles of HOV facilities in the county.

- Park-and-ride lots are located in many areas and new transit services have been added. A premium level of express service, called *Super Express*, was recently implemented on a few routes. This service, which focuses on long-distance trips, uses transit coaches with more comfortable seating and other amenities. The service is also express or limited-stop to provide greater travel time savings. Thus, the emphasis of the service is on providing users with travel time savings and enhanced comfort levels.

- Providing adequate enforcement has been another important feature of the system. The authority has worked closely with the California Highway Patrol and local police departments to provide adequate enforcement of the vehicle occupancy levels and other use requirements.

- Improvements and additions are being planned and developed for both the HOV system and the LRT system. Approximately 40 miles of new HOV lanes are scheduled to open over the next five years and nine more park-and-ride lots will be constructed. Additional buses are also scheduled to be added to the *Super Express* system.

Managing Demand on HOV Facilities

Adolf D. May, JHK & Associates — presiding

The Seattle I-5 North 2+ Demonstration Project

Cy Ulberg
University of Washington

Dr. Cy Ulberg provided a summary of the analysis conducted on the demonstration project lowering the vehicle occupancy level on the I-5 HOV lanes in Seattle from three or more persons per vehicle (3+) to two or more persons per vehicle (2+). The study was conducted for the Washington State Department of Transportation (WSDOT) by the University of Washington and the Texas Transportation Institute. Dr. Ulberg covered the following highlights related to the project and the evaluation.

- The I-5 North HOV lanes were opened in 1983 with a 3+ persons per vehicle occupancy requirement. In August 1991, the vehicle occupancy requirement was lowered to 2+ by WSDOT. The change, which was initially scheduled to last six months, was undertaken partially in response to legislative interest. The I-5 North HOV lanes are concurrent flow lanes north of downtown Seattle. The southbound HOV lane is 7.7 miles in length and the northbound HOV lane is 6.2 miles in length.

- The objectives of the study followed the overall objectives for the HOV lane system outlined by WSDOT. These included improving the person-movement capacity of the facility, providing shorter and more reliable travel times to HOVs, and maintaining the safe operation of the total freeway facility. Data were collected and analyzed on vehicle and person volumes, travel times, accidents, and public perceptions.

- Vehicle volumes in the morning and afternoon peak hours increased from an average of 500 to 600 vehicles per hour to 1,200 to 1,400 vehicles per hour during the demonstration. The number of three-person carpools declined and two-person carpools increased as a result of the change.

- The change in the vehicle occupancy requirement resulted in a different impact on travel time savings and travel time reliability in the morning and afternoon. Travel times did not change significantly in the morning. Travel times did increase in the afternoon peak period, however. This increase resulted from the higher vehicle volumes and a bottleneck that results from a lane drop and a merge.

- For the most part, the public seems to support the 2+ carpool designation. Some negative reactions were received from bus riders who indicated that bus travel times were not as reliable with the 2+ designation, however.

- The 2+ demonstration appears to have had mixed results. Although more people are using the lane, vehicle occupancy levels have not increased. Travel times for HOVs are lower in the afternoon peak period and travel times are less reliable. The change has had no apparent impact on safety.

- One of the recommendations made by the multi-agency steering committee was to further examine the use of travel time reliability measures for determining when changes should be made in vehicle occupancy requirements on the HOV lanes. Maintaining HOV lane speeds of 45 mph or greater 90 percent of the time over a six-month period was identified as an appropriate measure. During the afternoon peak period, the northbound HOV lane does not meet this standard. Thus, the potential of using a 3+ vehicle occupancy requirement in the northbound direction during the afternoon peak period is being considered.

The Pittsburgh I-279 2+ Demonstration Project

Tom Fox
Pennsylvania Department of Transportation

Tom Fox provided a summary of the experience with a demonstration project on the I-279 HOV lanes in Pittsburgh. For the demonstration, the vehicle occupancy requirement was lowered from three persons per vehicle (3+) to two persons per vehicle (2+) in August 1992. Mr. Fox presented the following information on the I-279 HOV lanes and the 2+ demonstration project.

- The Pittsburgh metropolitan area has a population of approximately 1.2 million people. The transportation system in the area includes freeways, HOV lanes, busways, LRT, and other elements. The I-279 HOV project is a reversible, two-lane, barrier-separated facility located in the freeway median. It is 4.1 miles long and has three entrances and exits.

- The I-279 freeway and HOV lanes were opened in 1989. The HOV lanes operate inbound from 5:00 a.m.

to noon. From noon to 2:00 p.m. the lanes are closed to reverse the operation. This procedure is partially automated, but maintenance workers also check the facility to make sure all vehicles have exited. From 2:00 p.m. to 8:00 p.m. the lanes operate in the outbound direction. Finally, from 8:00 p.m. to 3:00 a.m. the lanes operate in the outbound direction without any occupancy restrictions.

- Volumes on the freeway are currently exceeding design levels for the year 2007. The worst congestion occurs in the morning peak period. In 1991, a 24-hour volume count of the HOV lanes recorded approximately 1,400 vehicles. The volume measured during the peak hour was 345 vehicles. Although utilization levels continued to increase over time, the general public opinion was that the lanes were under-utilized at the 3+ occupancy requirement.

- Partially in response to this, legislation was introduced that would have required the Pennsylvania Department of Transportation (PennDOT) to lower the occupancy level from 3+ to 2+. Although this legislation was not approved, PennDOT decided to reduce the vehicle occupancy requirement to 2+ during the construction of a third general-purpose lane on southbound I-279.

- The vehicle occupancy level on the I-279 HOV facility was lowered to 2+ on August 10, 1992. An initial count taken shortly after the change indicates that the daily vehicle volumes on the HOV lanes have increased from approximately 1,300 vehicles to 3,600 vehicles. The peak hour volumes increased from some 279 vehicles to 949 vehicles and the morning peak period vehicle volumes increased from 447 to 1,500. A more extensive study will be conducted in November to better identify the impacts of the change.

The Houston Katy Freeway HOV Lane
3+ Peak Hour Requirement
Stephen Albert
Metropolitan Transit Authority of Harris County

Stephen Albert provided an overview of the Houston HOV lane system and the experience with variable occupancy requirements on the Katy Freeway (I-10 West) HOV lane. He noted that the HOV lane system started 12 years ago with a contraflow HOV lane demonstration project on I-45 North. Today, approximately 47 miles of a planned 96-mile system are in operation. Mr. Albert covered the following elements relating to the variable occupancy requirements on the Katy Freeway HOV facility.

- The Katy Freeway HOV lane is located in the median of I-10 West. It is a one-lane, reversible, barrier-separated facility that is 13 miles long. Access is provided by slip ramps from the general-purpose traffic lanes and by flyover ramps from park-and-ride facilities.

- The vehicle occupancy requirements on the Katy Freeway HOV lane have been changed a number of times since the facility was opened in 1984. At first, the lane was opened only to buses and authorized vanpools. Because of low volumes, the lane was then opened to authorized carpools with four or more persons. This was later revised to 3+ authorized carpools. Finally, the authorization was dropped and the required occupancy level was lowered to 2+.

- The lane operated with the 2+ requirement for a number of years and utilization levels continued to increase. In 1988, volumes of 1,500 vehicles during the peak hour were common. This resulted in congestion in the HOV lane, lower travel times, and reduced travel time reliability. As a result, the decision was made to implement a 3+ vehicle occupancy requirement during the morning peak hour. In 1991, the same requirement was placed on the afternoon peak hour.

- Initially, vehicle volumes in the morning peak hour dropped by about 64 percent as a result of the change to the 3+ occupancy level. Volumes declined from approximately 1,400 vehicles to 510 vehicles. The travel time delays that had been experienced were eliminated as a result. Although vehicle volumes declined, the average vehicle occupancy level in the lane increased from approximately 3.1 persons per vehicle to 4.5 persons per vehicle. The vehicle volumes have continued to increase, with the morning peak-hour volumes currently averaging 900 to 1,000 vehicles. The same trends appear to have happened in the afternoon.

- The variable hour vehicle occupancy requirement has made enforcement more difficult. The barrier-separated design does help enforcement and METRO police regularly monitor the lanes. However, enforcement personnel indicate that the variable occupancy requirement is more difficult to enforce.

Arterial Street HOV Applications

Don Samdahl, JHK & Associates — presiding

Community Transit Study

Kern Jacobson
Parsons Brinckerhoff Quade & Douglas

Mr. Jacobson discussed a study underway in Snohomish County examining arterial street HOV applications. Community Transit, the public transit operator in the county, is sponsoring the study. Mr. Jacobson covered the following points in his presentation.

- Over the past decade, the Seattle area has developed a fairly extensive freeway HOV lane network. Recently, interest has focused on arterial street HOV applications. The current study sponsored by Community Transit is examining potential HOV facilities on arterial streets within Snohomish County.

- A number of issues associated with the potential use of arterial HOV treatments are being examined. First, signalized intersections must be addressed. Traffic signals can increase travel time and cause congestion. Next, the number of driveways along many arterials can cause conflicts with traffic. Also, pedestrians and the proximity of adjacent developments may cause problems.

- New operational objectives and criteria need to be developed for arterial street HOV projects. The differences between the freeway environment and the arterial street environment require different approaches.

- An arterial street HOV system will need to be integrated with state-of-the-art traffic signal control strategies. This field is rapidly evolving and presents real opportunities for coordination with HOV lanes.

- A number of alternative arterial street HOV applications can be considered. For example, many signal priority projects were developed during the 1970s, but most have been discontinued. The availability of advanced technologies has made this alternative more attractive and a number of areas are pursuing projects of this type.

- Another alternative involves the use of the right-hand lane, or curb lane, for an arterial street HOV lane. This approach provides easy access for buses, but can cause problems for turning vehicles at intersections or driveway access points. Left-hand lane HOV projects can be difficult for bus operations, as the passenger door is on the right-hand side of the bus. Using a center lane for HOVs is also an option. This approach was used by many streetcar systems, including the system still in operation in New Orleans.

- Using contraflow HOV lanes on arterial streets may also be a possibility. This approach would reserve a traffic lane in the off-peak travel direction for use by HOVs in the peak travel direction. Also, an entire street could be dedicated to HOVs.

- Short segments of HOV lane, or queue jumps, may be appropriate at severely congested intersections. Another small-scale HOV treatment would involve reserving one lane of a multi-lane left turn bay for HOVs.

- All of these alternatives—and an assortment of variations and combinations—were examined in the study. Once all the possible alternatives were identified, a fatal flaw analysis was conducted focusing on the four criteria of financial viability, geometric feasibility, functional adequacy, and public access. Approximately ten alternatives emerged from this analysis. Those alternatives are being examined in more detail. Recommendations will be made on the appropriate approaches for different areas of the county.

The Toronto Experience

Steve Schijns
McCormick Rankin

Mr. Schijns provided a presentation on the status of arterial street HOV projects in the Toronto area. He discussed the arterial street HOV lanes currently in operation and those in the planning and development stages. Mr. Schijns covered the following topics in his presentation.

- Approximately two million people live in metropolitan Toronto and some four million people live in the greater Toronto area. The population of the greater Toronto area is projected to increase to six million people by the early 21st century. The urban transportation system in Toronto consists of the freeway network, arterial streets, the rapid transit system, and other transit initiatives. There are approximately 700 kilometers of arterial streets in the metropolitan area, which is much greater than the combined length of the freeway and subway systems.

- The combination of the GO commuter rail system, the subway, the streetcars, and the bus network provides Toronto with one of the best transit systems in the world. Approximately 1,400 buses operate on 140 routes in the area. Many of these routes connect to the rapid transit system at stations.

- Currently, seven bus lanes are in operation on arterial streets in the Toronto area. The lanes differ in application and orientation but all provide priority treatments for buses. The east-west reserved bus lanes were implemented in 1971 and 1972 to provide better access to a major transit terminus. This project proved to be very successful and is still in operation. In 1974, pilot bus lanes were opened on five streets to provide faster travel speeds for buses. These projects reserved the curb lanes for bus use during the peak periods. Two of these projects are still in operation today. In 1982, a suburban arterial street bus lane was implemented, and in 1990 a downtown bus lane was implemented. This last project provides reserved lanes for buses, taxis, and bicycles between 7:00 a.m. and 7:00 p.m. Traffic controls, limited parking, and turn restrictions were also implemented. Although it initially generated some controversy, the project has been very successful.

- The potential to add bus lanes in many suburban areas is being considered. Using the curb lane, or widening the street to add a bus-only lane, is also being considered. Many of these streets have very high bus volumes and with increasing traffic congestion bus lanes or other priority measures are needed. Care must be taken in the development of arterial bus lanes, however, so that they do not negatively impact traffic in the general-purpose lanes. Some of the early projects did cause more congestion for general-purpose traffic. Learning from past experiences is important to ensure that future projects benefit all traffic.

- Another issue that often arises with the use of arterial HOV lanes is parking. This is a problem in Toronto, especially in the downtown area. Enforcement is needed to help prevent illegal parking in the bus-only lanes.

- Both widening suburban arterials to add HOV lanes and converting existing lanes are being examined. It is anticipated that several new projects will be initiated that focus on enhancing all aspects of the transit system in the Toronto area. The expanded use of arterial HOV projects will play an important role in that effort.

The Los Angeles Experience
Bob Huddy
Southern California Association of Governments

Mr. Huddy provided an overview of the transit and transportation system in Southern California. He discussed the recent studies that have been conducted examining the use of arterial street HOV lanes and the current status of different activities. Mr. Huddy addressed the following points in his presentation.

- The Southern California region is slightly larger than the state of Massachusetts. There are six counties and some 180 municipalities within the region. Approximately 14 million people live in the region. Recent forecasts project a population of close to 21 million people by the year 2010.

- Traffic congestion is a major problem in the region. It has been estimated that congestion is costing the area some $2 billion to $4 billion annually. If nothing is done, congestion levels will continue to increase in the future and will continue to be a hinderance to the economic growth of the area.

- In order to address these concerns, an aggressive multimodal approach is being pursued. This includes commuter rail, rail rapid transit, light rail transit, new freeway construction and expansion of existing facilities, HOV lanes, an improved traffic management system, and other elements. Over 1,200 miles of freeway HOV lanes are being planned for the region. Arterial HOV lanes are also being considered.

- A recent study focusing on the express bus network in the area highlighted the need for improved operations on arterial streets. It also appears that carpools could benefit greatly from arterial street HOV treatments. The study of express bus service identified a minimum threshold of approximately 20 to 30 buses an hour for a concurrent flow arterial HOV lane and 40 to 60 buses an hour for a contraflow lane. Without such utilization levels, high violation rates can be expected.

- Coordinated traffic signals or priority signal treatment should be considered for use with arterial street HOV lanes. These techniques can increase operating speeds for HOVs and reduced travel times. A variety of advanced technologies should make these approaches more feasible in the future.

- Providing bus stop areas and passing lanes for buses also should be considered with arterial street HOV lanes. The Spring Street HOV lane in Los Angeles uses double lanes in some areas to provide space for buses to pass those that have stopped to pick-up or drop-off passengers. For example, approximately 70 bus routes use the Spring Street HOV lane in front of the Los Angeles City Hall. Before the second HOV lane was added, there was a good deal of congestion in the area, resulting in slower travel times.

- A number of possible arterial street HOV applications are being considered in the region. These include the potential use of old streetcar rights-of-way and expanding a tunnel under the airport to provide an HOV lane. A variety of approaches will be needed in the future to address the growing population and traffic congestion levels in the Southern California region.

The Hartford Study
Owen Curtis
JHK & Associates

Mr. Curtis provided an overview of a study being conducted in the Hartford, Connecticut area examining possible links from a freeway HOV lane to the downtown. He covered the following topics in his presentation.

- The Hartford metropolitan area has a population of approximately one million people. It is the state capital, and is also known as the insurance capital of the country. The I-84 HOV lanes, which were constructed as part of a freeway widening project, were opened about three years ago. The facility uses a 3+ vehicle occupancy requirement. Utilization levels have been relatively modest with the 3+ requirement. A result, a 2+ vehicle occupancy requirement will be implemented later this year. Use is projected to triple with the 2+ requirement.

- HOV lanes are also being implemented on I-91. A 2+ vehicle occupancy requirement will be used on the I-91 HOV lanes. The I-91 facility will open at the same time the occupancy requirement on the I-84 lanes is lowered to 2+. Thus, both HOV facilities will have the same operating requirements.

- The HOV lanes on both I-84 and I-91 end before the downtown Hartford area. The current study, which is sponsored by the Hartford Ridesharing Corporation, is examining alternative ways of bringing HOV traffic from the freeway HOV lanes into the downtown area. A major congestion point occurs on a bridge approaching the downtown area, but the HOV lanes end before that point. Alternative methods of providing HOV lanes on the bridge are being considered. Use of the shoulder by HOVs during the morning peak period appears to be the most viable alternative. The potential to combine this approach with a reversible lane for general-purpose traffic is also being considered. HOV treatments at off-ramps were also examined.

- Potential HOV treatments are also being examined in the downtown area. The use of HOV lanes on some downtown streets and preferential treatment at signalized intersections are two examples of possible approaches. These could connect to the existing facilities in the downtown area.

- The results from the study will be considered by the Connecticut Department of Transportation and others. It is anticipated that additional analysis may be needed on some of the study recommendations.

State and Local Policies Supporting HOV Facilities

Cy Ulberg, University of Washington — presiding

Policies in Seattle and Washington State

Les Jacobson
Washington State Department of Transportation

Les Jacobson reviewed the status and content of recent policies in the Seattle area and Washington State supporting the development of HOV facilities and the use of buses, vanpools, and carpools. He covered the following major points in his presentation.

- There are several types of policies in Washington addressing HOV facilities. They focus on different aspects of the system and help ensure consistency. Policy issues include operating procedures, programming priorities, and funding.

- The Washington State Department of Transportation (WSDOT) used a process involving different groups within the agency to develop its HOV policies. An interdisciplinary study team was formed to examine the issues and make recommendations. The group first identified the policy issues that needed to be considered. Next, the study team developed draft policies that addressed the identified issues. The group then recommended a set of policies to the WSDOT executive management. The consolidated HOV policy document was finalized in November 1991 after about 1½ years of work.

- Procedures were also established for reviewing and revising the policies, and for dealing with new issues. An HOV Policy Board was formed—comprised of top agency personnel—to review and approve any changes. This group will receive recommendations on the appropriate course of action from the HOV Policy Task Force, which is comprised of department managers. The task force, which is responsible for examining the technical issues, serves at the request of the HOV Policy Board. The task force is supported by different issue groups that address specific concerns in more detail.

- The HOV policies help WSDOT communicate the goals and objectives of the HOV system to the public, the legislature, and other agencies. The policies help describe what objectives the department hopes to accomplish, how it will accomplish those objectives, and how it will measure success. It is important to communicate these clearly to the public and the legislature. Involving other agencies is also critical, given the multi-agency nature of developing and operating HOV projects.

- The HOV policies provide a clear statement of WSDOT's objectives and policies related to HOV facilities. These are provided in a single document which can easily be understood by all groups.

Policies in the Washington, D.C. Area

John Matthias
Maryland National Capital Parks & Planning Commission

John Matthias provided a summary on the status of planning efforts for HOV facilities in the Maryland suburbs of Washington, D.C. and policies relating to HOVs. His presentation covered the following points.

- Currently, there are no HOV lanes in operation on freeways in Maryland. However, construction should start soon on three facilities, and one project is in the planning stage. A short bus priority lane is in operation on US 29. This facility uses the shoulder to allow buses to bypass a major congestion point. Eleven miles of HOV lanes on I-270 have been built, but will not be opened until the necessary connections are provided. The major HOV facilities in the Capitol Area are in Virginia. It appears that Virginia developed HOV lanes while Maryland was examining commuter rail alternatives. Now Maryland is exploring HOV and Virginia is looking at commuter rail.

- The Maryland State Highway Commission recently announced a project planning study to examine the feasibility of HOV lanes on the Washington Beltway (I-495). A statewide plan for a network of HOV lanes, which includes the Baltimore and Washington, D.C. areas, has also been developed.

- Several planning efforts related to HOV facilities are also occurring within Montgomery County. The county-wide Master Plan includes a long-range project to identify a network of transitways and HOV lanes to connect with programmed facilities in the region. HOV lanes were identified to help meet the transportation needs associated with the land use and zoning recommendations contained in the approved Master Plan.

- The Metropolitan Washington Council of Governments (WASHCOG) is currently conducting a circumferential transit study. This study is examining the potential need for transit services, HOV lanes, and other supporting elements to serve circumferential trips in the region. The current system, like most metropolitan areas, focuses on serving radial trip patterns. The WASHCOG study is being coordinated with local planning efforts.

- The recent opposition to the HOV lanes on the Dulles Toll Road, and the subsequent action by Congress lifting the HOV requirement, indicates that more emphasis needs to be placed on educating the public and promoting the use of HOV lanes before they are opened. In addition, the supporting facilities, adequate signing, and transit services need to be present to make the HOV system work.

- Montgomery County has an Adequate Public Facilities Ordinance that is intended to help ensure that the infrastructure needed to support new developments is in place. Under the ordinance, subdivision requests by developers will not be approved unless the public facilities necessary to support the proposed development are in place. Water, sewer, and transportation infrastructure elements are all covered under the Adequate Public Facilities Ordinance. The intent of the law is to encourage developers to improve the public facilities needed to support their projects.

- Each local jurisdiction needs to provide a balance of transportation facilities, services, and policies to support local development, the needs of its residents, and metropolitan goals. HOV facilities provide one approach. HOV facilities are not the answer to every problem, but they can be an important element in the overall process of addressing our transportation needs.

Policy-Making for HOV Corridors in the Greater Montreal Area

Robert Olivier
Montreal Urban Transit Society
and
Ottavio Galella
Trafix Consultants

Mr. Olivier and Mr. Galella discussed the development and status of HOV facilities in the Montreal area. The approach in Montreal has focused on providing priority treatments for buses. Mr. Olivier and Mr. Galella covered the following topics in their presentation.

- The success of the Pie IX Boulevard bus-only lane led to the examination of other potential bus priority lanes in the Montreal area. Passenger and bus volumes were used to identify other locations where HOV lanes appeared to be appropriate. The Park Avenue bus-only lane was the next project to be implemented as a result of this work.

- The Park Avenue facility saves about 10 to 15 minutes for buses. Bus service on the street is very heavy, with two-minute headways in the peak hour. Implementation of the lane and the reoriented bus service also provided direct access for passengers into the downtown area without having to transfer to the subway. Implementation of the project also had to consider changes in parking, signalization, and turn restrictions.

- A new model was developed to help evaluate the Park Avenue facility and other possible projects. The model includes seven categories and 34 criteria. The seven categories considered include public transportation, circulation, parking, traffic, infrastructure, social control, and accessibility. Within each of these categories there are a number of criteria that are examined for different alternatives.

- As in many areas, parking was a major issue. Many business owners felt that removing parking would hurt their business. Focus groups, comprised of businesses and local residents, were used to provide input into the study process. Parking was one of the big concerns raised by these groups.

- The Montreal area has a very extensive and efficient Metro system. The implementation of this system resulted in many passengers having to transfer from buses to the Metro to complete their journey. This has resulted in longer travel times for many riders. Bus lanes, such as the one on Park Avenue, can help provide direct access into the downtown for bus riders without having to transfer to the Metro. Determining the best combination of transit improvements and services is a big question.

- Montreal has been experiencing increasing levels of urban sprawl and traffic congestion. It appears that all forms of public transit can assist in addressing these problems. Bus-only lanes, HOV facilities, and congestion pricing can all be used to try to improve traffic congestion and mobility levels. The policies and programs for all types of transportation improvements need to be coordinated, however. Recently, greater emphasis has been placed on HOV projects rather than the development of new freeways or extensions to the Metro system.

- As a result of new interest in HOV projects, a number of new facilities are being examined. Feasibility studies are underway on a number of freeways and arterial streets. Thus, it appears that a number of new projects may be implemented in the Montreal area over the next few years.

- One suggested approach was to develop a regional plan from the bottom up. That is, plans should be developed at the local level. The different projects could then be implemented one at a time. The projects should also recognize local and regional environmental concerns. Starting small allows you to build a successful project and develop a regional plan and system.

Regionwide HOV Systems

Donald G. Capelle, Parsons Brinckerhoff Quade & Douglas — presiding

The Southern California Experience

David Barnhart
Los Angeles County Transportation Commission

David Barnhart provided an overview of the status of HOV planning activities in the Los Angeles metropolitan area. He discussed the HOV facilities currently in operation in the area, HOV projects in the planning and development stages, and other elements of the transportation system. Mr. Barnhart covered the following topics during his presentation.

- In 1990, the population of Los Angeles County was approximately nine million. By 2010, the population is expected to increase by some 15 percent. Coordinating transportation activities in the county requires working with the 89 local units of government, the county, the Southern California Regional Transit District (SCRTD), the California Department of Transportation (Caltrans), the Los Angeles County Transportation Commission (LACTC), and other groups. The LACTC is responsible for coordinating the planning and programming of transportation improvements in the county. The county has approximately 500 miles of freeways, which represents a relatively small system when compared with the population and the number of registered vehicles.

- Traffic congestion is a significant problem in the area. Currently, a multimodal approach is being taken to address this problem. The multimodal program includes HOV lanes, commuter rail, LRT, and other elements. Approximately 300 miles of HOV lanes are programmed to be completed over the next 30 years, with 200 miles in operation within the next 10 years. The development of the HOV system is being supported by TSM and TDM programs, and other measures.

- A 400-mile rail system is also being developed. The commuter rail portion accounts for about half of this system. Los Angeles County is one of five counties involved in the METROLink system. Additional buses are also being purchased and bus service is being expanded. It is anticipated that the peak hour bus fleet will grow from some 2,500 buses to over 3,000 buses over the next 20 years.

- The TDM component of the plan is the least well-defined element of the program. Currently, there are 45 locally-funded demonstration projects, including child care facilities at park-and-ride lots, telecommuting programs, and support for Transportation Management Associations (TMAs).

- Concerns over air quality represent one of the driving forces behind the development of the multimodal plan.

- Currently, HOV lanes in operation in the Los Angeles area include the 12-mile San Bernardino Freeway Busway. Orange County to the south has also made a substantial commitment to developing an extensive HOV lane system.

- The San Bernardino Freeway Busway is used by some 11,000 people in the two-hour afternoon peak period. Approximately 60 to 70 buses per hour operate on the facility. The remaining vehicles are carpools with three or more passengers. Park-and-ride lots and bus transfer stations are located at strategic points along the corridor.

- Other improvements being made in the area include HOV bypass lanes at freeway ramp meters, a freeway service patrol to help motorists, cellular call boxes, and the traffic management system.

- Funding for all these improvements is coming from a variety of sources. Federal funding through different ISTEA programs will continue to be utilized along with local and state funding.

Dallas System Plan

Russell Henk
Texas Transportation Institute

Mr. Henk provided an overview of the development of the Dallas HOV System Plan. He focused on the process used to develop the draft plan. Mr. Henk covered the following points in his presentation.

- A freeway HOV system plan for the Dallas area has been under development for a number of years. The planning horizon for the plan is 2015. The development of the system plan has been conducted by the Texas Transportation Institute under contract to the Texas Department of Transportation (TxDOT). The North Central Texas Council of Governments (NCTCOG) and

Dallas Area Rapid Transit (DART) were also involved in the planning process.

- The goal of the plan is to provide an intermediate step between the macroscopic level of planning conducted by NCTCOG and the detailed design and analysis performed by TxDOT. To accomplish this goal, a unique process was used to examine alternative scenarios of HOV and general-purpose lane improvements. The process involved five steps. These steps were: data input, development of different alternatives, cost analyses, prioritizing and selecting alternatives, and operational analyses.

- A variety of information was gathered on existing conditions during the first phase. This included data on vehicle volumes, occupancy rates, origin-destination information, and systemwide constraints. Future peak hour volumes were estimated based on this information.

- A number of alternatives were then developed and tested. Adjustments in vehicle volumes due to congestion through both time and modal shift were built into the process. Using data from the Houston HOV lanes, a relationship between daily HOV ridership and general congestion levels was identified. In general, this relationship indicates that HOV ridership increases proportionally with increased congestion levels. Houston and Dallas have different *K* and *D* factors, however. The *K* factor is the percentage of total traffic occurring during the peak hour and the *D* factor is the directional distribution of the traffic. The differences in the *K* and *D* factors were adjusted for the Dallas conditions and plotted on a graph. The results work well in the analysis of radial HOV and freeway facilities, although they do not appear as accurate with circumferential facilities.

- Approximately 10 to 15 alternatives were developed and examined for each freeway corridor. One example was provided that compared five general alternatives. The alternatives were: no-build, additional general-purpose lanes, express lanes, two HOV lanes, and one HOV lane. A vehicle occupancy requirement of two or more persons (2+) was used for the HOV lanes in this example, although both 2+ and 3+ requirements were examined.

- The critical lane volumes were examined for each alternative in this example. Once the volume reaches approximately 2,400 vehicles per hour, the capacity is reached and congestion continues to occur before and after the peak hour. This result happened when the no-build alternative was analyzed. The analysis further indicated that congestion levels were not too severe with the addition of general-purpose lanes. The addition of general-purpose lanes and one HOV lane begins to approach congested levels, while the alternative with two HOV lanes provides a good level of service.

- The third phase of the process provided a cost analysis of the different alternatives. This included estimating the congestion delay cost to identify the total cost to the public. Using this method, the no-build alternative was the most expensive option and the two-lane HOV alternative was the least expensive. The different alternatives were ranked based on these general costs. If two alternatives had similar costs, the option that provided greater system continuity or flexibility was rated higher.

- The last step examined the operational issues associated with each alternative. Concerns associated with weaving and merging were studied for all options.

- This methodology has been applied to the entire freeway system in the Dallas area. The final draft plan has been submitted to TxDOT and approval of the 2015 plan is anticipated in the near future.

Integrating HOV and Transit Planning in Seattle
Jim Parsons
ICF Kaiser

Mr. Parsons discussed the various transit-related planning activities occurring in the Seattle area and how the different projects are being coordinated. He described the following aspects of the Puget Sound Regional Transit Project and other studies.

- The Puget Sound Regional Transit Project (RTP) evolved from a series of studies conducted during the 1980s. The RTP represents the cooperative efforts of Seattle Metro and the three other transit systems in the Puget Sound area. Combined, these systems provide service from the Everett area in the north to Tacoma in the south. Approximately 2½ million people currently live in this area and the population is projected to grow by another one million by 2010. The goal of the RTP was to develop a comprehensive package of transit improvements for the area.

- A draft plan was prepared and presented for public review a month ago. It is anticipated that a final plan will be adopted in 1993. The draft plan includes light rail transit (LRT), commuter rail, and HOV lanes. The HOV network builds on the current system and provides greater continuity between the different segments. Further, at some future point, some of the HOV lanes could be converted to rail. For example, I-90 and the downtown bus tunnel were both designed to accommodate conversion to rail in the future, although modifications may be needed.

- The RTP, especially the rail component, was driven partially by the land use requirements of the State Growth Management Act. This act, which was approved by the legislature two years ago, requires that land use plans be developed and adopted by local jurisdictions by the end of 1993. These plans must contain three critical elements. These are the designation of urban growth boundaries, the identification of key activity centers, and the identification of the infrastructure to support the activity centers.

- The HOV lane component was developed based on the existing network. The HOV lane system, which was designed by the Washington State Department of Transportation and referred to as the core system, follows the freeway network. In addition to adding extensively to the freeway HOV lane system, HOV lanes on the arterial street system were included as well, based on the projects identified in *Vision 2020*. In some corridors both rail and HOV lanes are proposed, while in others it is anticipated that rail may replace the HOV facilities at some point in the future.

- The cost of the RTP is estimated to be between $9 billion and $10 billion. Increasing the gasoline tax, which requires voter approval, is one of the proposed funding methods. If the plan and financing approach is approved by the voters, it is anticipated that implementation would start within a year. At this point, it appears that the public supports the plan.

The Toronto Approach
Tom Mulligan
Municipality of Metropolitan Toronto

Mr. Mulligan provided an overview of the regional approach used in Toronto to plan, develop, and operate HOV lanes. He also discussed the general characteristics of the area and the regional transportation system. The following are the major points of his presentation.

- Metropolitan Toronto is projected to have a population of six million people by 2010. METRO Toronto is a federation of six local jurisdictions and is responsible for regional facilities including rapid transit, the arterial road network, and the surface transit system. Toronto is well-served by a multimodal transportation system. The system includes provincial highways, a surface and rapid transit system, and local roads.

- In the past, HOV lanes have not been considered extensively because of the good rail and bus system. However, increased congestion in suburban areas has had a negative impact on the cost-effectiveness of the surface transit system. Decreasing auto occupancy levels and increasing automobile use have resulted in increased congestion levels in many areas. This has resulted in higher transit operating costs just to maintain existing service levels.

- HOV lanes have been considered to make the overall transportation system more efficient. Further, HOV lanes support a number of regional goals. The Toronto Transit Commission (TTC) carries approximately 20 percent more people on buses than the combined subway and commuter rail system. Thus, HOV lanes on arterial streets and some freeways will help improve the efficiency of the bus system. HOV lanes can also increase capacity in corridors where right-of-way for additional roadway expansion is not available. HOV lanes also address environmental concerns and form a basis for TDM programs.

- An HOV network was first proposed in 1990 as part of a congestion management strategy. A more detailed study was then conducted to examine the role HOV lanes could play in the region, to develop planning and design guidelines, and to outline a potential HOV lane network. Organizational issues were also addressed and operational concerns were identified.

- The study focused on several objectives. Identifying approaches to increase person movement was one of the major objectives. Improving surface transit operations and air quality levels were important objectives. A variety of information and factors were considered in the study. Several different network alternatives were examined. These included a do-nothing option, a surface transit priority alternative, a radial intercept network, a grid HOV lane network, and a more traditional freeway or expressway HOV lane system. The grid network was selected because of the potential to serve more current activity centers, future development areas, and heavily used transit routes. Further, it fit best with the future proposals for expansion of the rail system.

- A more detailed analysis was then conducted to determine the most appropriate roads for HOV lanes. Factors included in this analysis were existing bus ridership levels, potential use by carpools, links to suburban development nodes, connections to other interregional networks, and implementation opportunities. Most arterial roads would need to be widened to accommodate HOV lanes. However, in some older areas, such a dense grid of arterial streets exist that it would be easier to take an existing general purpose lane because traffic could be accommodated on another street. In new suburban areas this option is not available, however. Existing arterials would need to be widened in these areas to accommodate HOV lanes.

- The study suggested that an HOV lane network is both feasible and warranted in Toronto. The plan focuses on a long range network of HOV lanes in suburban areas with strategic links into the central area. A 30-year time period to develop the HOV lane network was proposed. Implementation would be staged and would begin with the development of curb-side HOV lanes. Also, consideration of HOV lanes will be included in future roadway development plans. Rerouting of buses to take advantage of the phased implementation of HOV lanes is also being examined. Enforcement issues are being considered and the police are being included in the planning and implementation process.

- The first stage of implementation will be phased in over the next ten years. An environmental assessment will be needed if roadways are widened. Ongoing activities at this point include developing ridesharing strategies and HOV parking incentives. A communications strategy is also being developed. Overall, the HOV program has been well received by the public in the Toronto area. By the spring of 1993 implementation of some element should be initiated.

New HOV Project Experience

Heidi Stamm, Pacific Rim Resources — presiding

The Dallas Contraflow Lane and Moveable Barrier

Chris Poe
Texas Transportation Institute

Mr. Poe provided an overview of the East R. L. Thornton Freeway (I-30) contraflow HOV lane in Dallas, Texas. He discussed the background to the project, its design and operation, and current utilization levels. Mr. Poe covered the following points in his presentation.

- The I-30 contraflow lane is the first freeway HOV lane in North Texas. Located on the east side of Dallas, the project represents the joint efforts of the Texas Department of Transportation (TxDOT) and Dallas Area Rapid Transit (DART). The Texas Transportation Institute assisted in the planning and design of the facility and is involved in the ongoing monitoring. The facility also represents the first use of the moveable-barrier technology with an HOV lane.

- I-30 is an eight-lane radial freeway located on the east side of the Dallas CBD. The facility experiences a high directional split in the peak periods. Because of this, the planning process focused on the use of a contraflow lane. In order to provide a safe operating environment for all types of HOVs, the use of a moveable system was explored.

- A phased opening of the contraflow lane was initiated in September 1991. Only buses were allowed to use the lane during the initial testing phase. Carpools with three or more people were then allowed to use the facility and after about two weeks 2+ carpools were allowed on the facility.

- Prior to the opening of the HOV lane, morning peak hour travel speeds averaged approximately 22 mph. Currently, operating speeds in the general-purpose lanes average about 25 to 30 mph and speeds in the HOV lane average 50 mph. Travel speeds for both the general-purpose lanes and the HOV lane are slightly lower in the afternoon.

- Currently, the morning peak hour vehicle volumes in the HOV lane are averaging approximately 55 buses and 1,300 carpools. The 55 buses are moving some 1,500 passengers and the carpools carry an additional 2,800 passengers. Thus, during a typical morning peak hour, just 1,355 vehicles carry a total of 4,300 people on the HOV lane.

- Vehicle volumes in both the HOV lane and the general-purpose lanes have been increasing since the project was implemented. Vehicle volumes in the HOV lane have increased by about 45 percent, while volumes in the general-purpose lanes have increased by some 20 percent. Overall, the person movement through the corridor has increased by approximately 55 percent in the morning peak hour.

- The growth in vehicle occupancy rates on I-30 has been about 10 percent to 15 percent since the HOV lane opened. In comparison, the growth in vehicle occupancy rates on other freeways in the Dallas area which do not have HOV lanes has been less than 2 percent. The vehicle and person volumes in the HOV lane also compare favorably with those observed on the Houston HOV lanes.

- Enforcement activities were very visible during the initial phases of the project. Random enforcement is now conducted and a demonstration project is being funded to look at applications of advanced technologies for enforcement of the HOV facility.

- The barrier transfer vehicle operates at about four miles per hour. In the morning it takes approximately 90 minutes to set up the lane. The vehicle starts at 4:00 a.m. and the lane is open at 6:00 a.m. In the afternoon, the set-up starts at 2:30 p.m. and the lane opens at 4:00 p.m. To date, the barrier transfer machine has worked very well and only a few problems have been encountered.

- Overall, the project objectives have been met. Person movement on the facility has been increased without negatively impacting the operation of the general-purpose lanes. The public and the media have been very supportive of the project and it has received positive national attention.

I-394 in Minneapolis
Craig Robinson
Minnesota Department of Transportation

Mr. Robinson discussed the I-394 HOV facility in the Minneapolis area, including the development and status of the project. He covered the following points in his presentation.

- I-394 represents the last segment of the Interstate system to be completed in the Minneapolis-St. Paul metropolitan area. The freeway and HOV lanes are approximately 11 miles in length, running from downtown Minneapolis through the western suburbs.

- The final design of the facility includes two general-purpose lanes and two different HOV treatments. At the end closest to downtown there is a three-mile segment of two-lane, barrier-separated reversible HOV lanes in the median. To the west of State Highway 100, the design changes to eight miles of concurrent flow HOV lanes. The design of the facility was influenced by state legislation which limited the cross section to no more than six freeway lanes.

- An interim HOV lane was used during the construction of I-394, which was built along the alignment of an existing signalized trunk highway. The interim lane, marketed as the "Sane Lane," was implemented to help manage traffic during construction and to introduce the HOV concept to motorists in the corridor.

- The I-394 project also included the construction of three large parking garages on the edge of downtown Minneapolis. The garages have approximately 6,000 spaces. Direct access is provided from the HOV lanes and reduced parking rates are provided for carpools and vanpools. The garages also contain bus transfer and passenger waiting areas.

- Park-and-ride lots and bus transfer centers are also located at strategic points along the I-394 corridor. Some 950 parking spaces are available in these lots. Improvements are planned for bus services operating in the corridor and a timed-transfer bus system is being implemented. HOV bypass lanes are also provided at the metered freeway entrance ramps. Currently, most of the lots are well utilized.

- The transition from the concurrent flow lane to the barrier-separated lanes occurs at the Highway 100 interchange. Wishbone-style bridges provide access into and out of the reversible lanes. At the east end of the reversible lanes, access is provided into downtown Minneapolis and to I-94 for traffic going to St. Paul and the University of Minnesota.

- Currently some 1,900 carpools are registered to park in the downtown Minneapolis garages at the reduced rates. The garages are connected to the extensive skyway system, providing convenient access to the downtown area. Approximately 400 to 500 vehicles used the Sane Lane during the morning peak hour. As of early October 1992, approximately 1,100 vehicles are using the completed HOV Facility in the morning peak hour.

Dundas Street in Mississauga, Ontario
Kees Schipper
City of Mississauga

Mr. Schipper provided an overview of the HOV lanes in Mississauga, Ontario. He discussed the HOV lanes currently in operation and those in the planning stage. Mr. Schipper covered the following points in his presentation.

- The city of Mississauga is located in the Toronto metropolitan area. The population of the greater Toronto area is approximately four million and the population of the metropolitan area is two million. The city of Mississauga has a population of 450,000.

- Dundas Street is a major east-west arterial in the metropolitan area. A five-kilometer HOV lane has been built along Dundas Street, with sections in both the cities of Mississauga and Toronto. Thus, planning for the facility included both cities and the provincial government. A total of 11 bus routes operate on the street.

- Planning for the facility took about five years. Coordinating planning and construction activities between the two municipalities required a good deal of effort. The development of the facility was initiated as a result of the Ten Year Transit Service Strategy Plan, which was completed in 1989. A number of improvements were recommended in this plan. A transitway, HOV lanes, and other priority measures for buses were basic elements of the plan. Other elements included express bus services, commuter rail, and improving connections to the existing Toronto Transit Commission services.

- The plan included a five-phased approach to implementing the recommended strategies. The Dundas Street HOV lanes represent one of the steps. An environmental assessment of the project was conducted in 1990–1991. Dundas Street has seven traffic lanes within the city of Toronto, but narrows to five lanes in Mississauga. A number of alternatives were considered as part of the assessment. Widening the street within Mississauga, adding a bus-only lane, adding an HOV lane, and extending the subway were all considered.

- Advantages of the HOV alternative included higher utilization levels from carpool use of the lanes, in addition to buses. Both 2+ and 3+ vehicle occupancy requirements were examined, and the 3+ designation was selected. The HOV lane was opened in January 1992. The HOV restrictions are in effect from 7:00 a.m. to 10:00 a.m. and from 3:00 p.m. to 7:00 p.m. Some bus routes have been diverted to Dundas Street from parallel streets. Overhead signs are used to communicate information on hours of operation and vehicle occupancy requirements. Enforcement was highly visible in the early phases, but has been reduced. Cautions were given to violators until July, after which a $53.00 fine was issued.

- The HOV lane has improved bus operating speeds and on-time performance. Initially, travel speeds increased so much that some buses were running ahead of schedule. Some problems have developed with buses platooning. Buses can not pass each other along most of the facility. Travel time savings have been greater in the afternoon peak period. Survey results indicate that bus riders view the HOV lane as a very positive improvement.

Dulles Toll Road HOV Lanes
Carole Valentine
Virginia Department of Transportation

Ms. Valentine discussed the experience with the Dulles Toll Road HOV lanes in the Northern Virginia/Washington, D.C. area. She covered the following points in her presentation.

- The Dulles corridor has two limited access roadways which run from Dulles International Airport to the Capital Beltway (I-495). The original roadway was a four-lane facility with right-of-way reserved in the median for future rail transit and parallel service roads on each side. The second roadway, known as the Dulles Toll Road, was built on the service road right-of-way. This four-lane facility was opened in 1984. By 1985 it was operating near capacity.

- Planning for the expansion of the facility began in 1985, focusing on HOV lanes. Construction began in 1989 and in August 1990 the Commonwealth of Virginia Transportation Board approved the designation of the median lanes as HOV lanes. A marketing program was started during the construction phase to make the public aware of the HOV lanes and to promote the use of high-occupancy modes.

- Construction of the new lanes occurred in three sections. As each section was completed, mixed traffic was allowed to use the lanes and implementation of the HOV restrictions was delayed until all segments were completed. The HOV lane designation was implemented on September 1, 1992 at a 3+ vehicle occupancy requirement.

- There was strong public opposition to the designation of the HOV lane after mixed traffic had been allowed to use it. An anti-HOV group began to lobby against the HOV restriction. In response to the concerns raised by this group, the Virginia Department of Transportation examined a number of alternatives. These included lowering the vehicle occupancy requirement from 3+ to 2+, changing the hours of HOV operation, and using the shoulders for travel lanes in the peak periods.

- The local anti-HOV groups lobbied the U.S. Congress, and on October 2, 1992 Congress passed an appropriations bill that contained a section dealing with the Dulles Toll Road HOV lanes. The bill required the removal of the HOV restrictions until July 1993. On October 5 the HOV restrictions were lifted and general-purpose traffic was allowed to use the lanes.

- The experience with the Dulles Toll Road HOV lanes illustrates some important factors. First, by allowing general-purpose traffic to use the HOV lanes during construction, the perception existed that the lanes were being "taken" for HOV use. Second, a 2+ HOV designation may have been more appropriate than the 3+ requirement. A 1988 study indicated that 3+ carpool volumes would be in the range of 400 to 500 vehicles during the morning peak hour. On the opening day, 388 vehicles used the lane during the morning peak hour. This number increased to 450 vehicles within a week and to 630 vehicles by October 1. These trends indicate the potential for continued growth in 3+ carpools. Even with this growth, however, the lane was still perceived by many as being under-utilized. Starting with a 2+ occupancy requirement may have generated a more positive public reaction. Finally, the experience shows that HOV lanes can become political issues.

HOV and Advanced Public Transportation Systems

Morris J. Rothenberg, JHK & Associates — presiding

APTS and HOV in the Boston Area

Matt Coogan
Rackemann Environmental Services

Mr. Coogan described a proposed project in the Boston area that combines a number of HOV and advanced public transportation system (APTS) concepts. The project, which focuses on I-90 and Logan International Airport, has been proposed by the Secretary of Transportation for the Commonwealth of Massachusetts. Mr. Coogan discussed the following elements of the proposed project.

- The project focuses on the I-90 corridor and Logan International Airport in the Boston area. The concept is to improve the intermodal transportation facilities and services in the corridor to encourage people not to drive to the airport. To accomplish this the project would combine the use of advanced passenger information systems, advanced vehicle communications, advanced public transportation systems, and enhanced congestion and incident management techniques.

- The concept focuses on providing a suburban transportation center for airport-bound travelers. Individuals would be able to park, check-in with their airline, and check their luggage at the center. They would then be transported to the airport in an advanced-design bus. The bus would use HOV facilities for the trip to help ensure travel time reliability and on-time arrival at the airport.

- The advanced passenger information system would include information on airline flights, bus departure times, and the current congestion levels on the freeway. This would provide passengers with all the information they need for their trip.

- Off-airport check-in centers are currently used in Japan and Scandinavia. Although there are issues that will need to be addressed, the concept is feasible in the U.S.

- The key to the project is to provide passengers with all the information and services they need. The use of advanced technologies will help accomplish this. Also, the use of advanced technologies and HOV facilities will help ensure that they reach the airport in time for their flights.

- The transit vehicles proposed for the project would use an advanced design. A number of advancements have been made recently in bus designs in both Europe and Brazil. The project would take advantage of these technologies and provide a comfortable state-of-the-art vehicle.

- The proposal would also tie into advanced traffic management systems (ATMS). This would provide real-time information on traffic conditions and congestion levels to both passengers and operators. Changes could be made in routing, scheduling, and HOV access as needed to respond to changing conditions.

- The coordination of all these could reduce traffic to Logan International Airport, provide more convenient airline check-in for passengers, and provide an enhanced multimodal transportation system in the corridor. A proposal has been submitted on the project and it is hoped that planning activities will be initiated within the next year.

The Ottawa AVL and Passenger Information System

Helen Gault
Ottawa-Carleton Regional Transit Commission

Ms. Gault provided an overview of the automatic vehicle location and control (AVLC) system and the automated telephone information system in operation in Ottawa. Ms. Gault covered the following points related to the use of these systems.

- The Ottawa-Carleton Regional Transit Commission (OC Transpo) has a long history of bringing computer applications and advanced technologies into the transit area. The goal of the various applications is to improve service and management and to provide better information to riders. One of the most important recent developments in this area is the automatic passenger counting system. Currently, 90 buses are equipped with microprocessors and infrared light beam detectors to record the movement of passengers and the activities of the buses. Although this is not a real-time system, it provides a great deal of information for planning and longer-term service scheduling.

- Another example is the *560* system, which is an automated telephone passenger information service. It provides information about the next two buses that will be arriving at a particular stop. It is currently based on fixed schedule information, but it will be upgraded with a link to the AVLC system, which will provide real-time information.

- OC Transpo established a number of goals when the AVLC system was being developed. These included keeping the system simple, avoiding duplication with other information systems, avoiding the need for complex equipment on the buses, and being able to manage and use the information collected from the system.

- The basic AVLC system focuses on equipping buses with automatic vehicle identification (AVI) tags. Overhead readers are located along the Ottawa Transitway at strategic points. The points were selected after detailed discussion on the locations that are most critical for obtaining information needed for operational and management decisions. Information is recorded on each tag-equipped bus as it passes under the readers. The tags each have unique numbers, allowing buses to be monitored throughout the system. The system is being designed to measure performance and track any service problems. The system also has an emphasis on the use of public information displays to provide information to riders.

- The system is being developed in three phases. The first phase involves a pilot project focusing on the Route 95 buses, which operate along the Ottawa Transitway. All of the Route 95 buses have been equipped with AVI tags. The objective of this phase was to test the hardware, software, and information processing capabilities.

- Phase 2 focuses on integrating the system with the control system and control staff. A good deal of training is needed with the development of the system. This phase also involves modeling the progress of buses and different control strategies on routes. This analysis is being conducted by Queens University and will be used for training purposes. The third phase involves the full implementation of the AVLC system.

- The public information aspect of the AVLC system involves two major elements. The first is the downtown public information system. This aspect of the program will provide information to waiting passengers on the sequence and timing of approaching buses. The second aspect will tie the real-time bus information into the *560* telephone system. This will provide callers with the real-time status of buses approaching their specific bus stop.

- In implementing both elements of the public information system, care is being taken to ensure that the system will work reliably and that the information will be accurate. This is critical to ensure that riders will find the system useful and beneficial. One of the benefits of the AVLC system is the ability to report missed trips and delayed buses.

- Another component of the system focuses on providing a cross-based reference on which bus is doing which piece of work. A second run plate has been added to the front of each bus to help with the development of this system.

- One longer-range project includes an examination of the potential use of a global positioning system (GPS). Another future project involves the provision of priority treatment to buses at traffic signals. This would focus on providing strategic priority to buses that are behind schedule or have full passenger loads.

IVHS America Perspective
Craig Roberts
IVHS America

Mr. Roberts provided an overview of the role of *IVHS America* and recent activities related to public transit and HOV facilities. He covered the following points in his presentation.

- A simple definition of IVHS is that it is the application of a wide range of advanced technologies to the surface transportation system to enhance its efficiency and effectiveness. Five general categories are used to describe the different IVHS applications. The categories are: advanced traffic management systems (ATMS), advanced traveler information systems (ATIS), commercial vehicle operations (CVO), automated vehicle control systems (AVCS), and advanced public transportation systems (APTS). There is a good deal of overlap between these categories. APTS includes the application of a variety of advanced technologies to benefit public transit.

- The mission of *IVHS America* is to foster public and private partnerships to aid in the identification, coordination, and development of advanced technologies. *IVHS America* has been chartered by the U.S. Department of Transportation as a federal advisory committee. Thus, *IVHS America* provides advice to the DOT on its strategic approach to IVHS, specific IVHS projects to undertake, and other aspects related to IVHS.

- *IVHS America* is organized around a structure of technical committees. A staff member from the U.S. Department of Transportation serves as secretary for each committee. This helps coordinate the different activities associated with research, development, and testing of IVHS technologies.

- *IVHS America* brings together a number of diverse groups and individuals interested in IVHS. In addition to the federal agencies, this includes state and local governments, automobile manufactures, trucking companies, computer and communication businesses, transit agencies, and the academic community.

- *IVHS America* has developed a Strategic Plan to help guide the implementation of IVHS over the next 20 years. Supporting the Strategic Plan is a Tactical Plan that contains information on specific projects. Activities are underway on developing a standardized system architecture and implementing a variety of operational tests. *IVHS America* has established a clearinghouse to maintain information on all the activities in the IVHS arena. Recently, accessing this information was made even easier through the implementation of an interactive system. The *IVHS America* Annual Meetings also provide a focal point for IVHS activities.

- The management structure of *IVHS America* is comprised of three levels. The Board of Directors is responsible for policy matters. The Coordinating Council oversees all the technical activities of the society. Under the Coordinating Council are the technical committees. The committees are oriented toward the functional areas of IVHS and other cross-cutting areas such as institutional issues, benefits, and legal concerns. Most of the real activities occur within the technical committees.

- There appears to be a wide range of IVHS technologies that are appropriate for use with HOV facilities. Providing information to people on how they can use HOV lanes, simplifying the formation of carpools, monitoring and enforcing HOV facilities, and providing overall improvements to transit services are just a few examples. The potential also exists to use barrier-separated HOV lanes for testing automated vehicle control and other advanced technologies. In addition, the working relationships established between transit providers and state transportation agencies to develop HOV lanes are an example of the types of relationships that will be needed to develop and implement IVHS projects.

Multimodal Opportunities
Sal Bellomo
Bellomo-McGee, Inc.

Dr. Bellomo discussed a current project being sponsored by FHWA and FTA. This study is focusing on responsive multimodal transportation management strategies and IVHS. Dr. Bellomo covered the following topics in his presentation.

- The ISTEA challenges the transportation community to creatively address transportation issues through a variety of approaches. FHWA and FTA have sponsored a study to examine the use of advanced technologies to enhance multimodal transportation management strategies. The two-year study started in the fall of 1991.

- A number of assumptions were made in the study associated with the IVHS environment. First, it was assumed that traffic signal control, traffic management, and transit fleet management systems will all have been implemented. Next, it was assumed that all these systems would be linked electronically or physically. Third, it was assumed that every major urban area would have a traffic management center (TMC) to collect, coordinate, and disseminate traffic and traveler information. Fourth, similar systems were assumed for commercial vehicles. Fifth, the relatively widespread use of in-vehicle navigation systems was assumed. Finally, TMCs would also be located in major rural highway corridors.

- The TMC represents a key element in most of the multimodal transportation management strategies examined. The size and function of a TMC will vary by location, however.

- Both urban and rural strategies were identified. The strategies focus on building on existing programs, expanding the market share of HOVs, utilizing resources more efficiently, and enhancing the effective movement of people and goods. At this point in the project, 27 multimodal scenarios are being considered. A total of 11 scenarios include HOV facilities. These alternatives focus either on increasing the use of HOV facilities or enhancing their operation. In addition to HOV lanes, a number of strategies include the provision of priority treatment for transit buses at traffic signals.

- A number of benefits could be realized by enhanced transit/HOV priority on roadway networks. Potential benefits include a better link between arterial streets and freeway HOV lanes, enhanced transit operation on arterial streets, additional incentives for HOV users, and providing transit with priority treatments during traffic diversions.

- Accident data recorders could be added to buses to help deal with passenger claims resulting from accidents or incidents. On HOV lanes these recorders could be used to notify the appropriate personnel of accidents or problems on the facility. Another idea is to use existing courier vehicles to also carry passengers. Excess capacity on courier vehicles could be used to transport people rather than goods. A variety of IVHS technologies could be used during air quality alerts to discourage SOV use and encourage HOV use. Congestion pricing and other approaches could be implemented during air quality alerts through the use of advanced technologies.

- The idea of thinking about and linking multimodal systems and IVHS holds great promise in fulfilling the intentions of the ISTEA and the CAAA. Many of these strategies include HOV facilities. Further, many alternatives focus on making HOV alternatives more attractive, thereby increasing the use of HOV lanes. The next steps in the study include refining the 27 alternatives, developing site selection criteria, identifying approximately 16 sites for operational tests, and recommending eight for further testing and refinement.

Air Quality Issues and HOV Facilities

Jonathan McDade, Federal Highway Administration — presiding

Defining the Issues

Jon Williams
Metropolitan Washington Council of Governments

Jon Williams discussed the relationships between HOV facilities and clean air planning using the Washington, D.C. area as an example. Mr. Williams provided a brief summary of the requirements of the 1990 Clean Air Act Amendments, discussed a sketch-level planning method for estimating the impacts of a regional HOV lane network, and examined the issues associated with non-work travel. Mr. Williams addressed the following topics in his presentation.

- The requirements of the 1990 Clean Air Act Amendments (CAAA) have focused on attaining air quality improvements as the controlling factor in the transportation decision-making process. The clean air requirements and elements of the 1991 ISTEA provide a major opportunity for the additional use of HOV facilities. This opportunity needs to be approached with foresight and care, however.

- One goal of the CAAA is to bring every metropolitan area into attainment for ozone and carbon monoxide. A fairly complex set of regulations is being developed to ensure compliance the in 57 non-attainment areas for ozone and 41 non-attainment areas for carbon monoxide. For example, the regulations continue the requirement that every federal-aid transportation improvement must be in conformance with an air quality plan for the area. The CAAA strengthens this conformity requirement and there are tougher standards.

- In 1993, the State Implementation Plans (SIPs) must be amended so that by 1996 emissions are reduced by 15 percent from the 1990 base. A full SIP revision is due in 1994 that will outline how full attainment will be accomplished. If a 15-percent reduction is not realized by 1996, programming of Transportation Control Measures (TCMs) will be required in serious non-attainment areas. In severe non-attainment areas, the TCMs must be programmed in 1992. HOV facilities are among the 16 TCMs listed in the act. Serious non-attainment areas are expected to meet the requirements by 1999, with severe areas achieving attainment by either 2005 or 2007.

- The EPA can implement sanctions—including withholding federal funds for transportation improvements—in areas where the state or MPO does not perform the necessary planning or implementation functions. Certain projects, including HOV lanes, are exempt from these sanctions. Thus, the CAAA supports the development of HOV facilities in a number of ways. One part of the ISTEA, which provides 90 percent federal funding for HOV projects, provides further incentives to the development of HOV facilities.

- Existing HOV facilities in the Washington, D.C. metropolitan area include the Shirley Highway, I-66, and a short arterial HOV lane on Route 1 in Alexandria. Programmed facilities include extensions of the I-66 and the Shirley Highway HOV lanes, a new facility on the Dulles Toll Road, and on I-270. Additional facilities have also been proposed. The full system would include about 250 miles of HOV lanes.

- The Metropolitan Washington Council of Governments (WASHCOG) has examined the potential impacts of this system on the regional air quality. This is an important issue in developing the SIP and other plans. To assist in estimating the air quality impacts of HOV projects, WASHCOG developed a quick-response modeling procedure, which is now being used to analyze different options.

- The quick-response model is based on a comparison of two transportation networks. One network contains only the existing HOV facilities, while the other contains the full program. HOV travel times are estimated by subtracting zone-to-zone HOV network travel times from the base case network travel times. A pivot point model is then used to estimate mode shifts and changes in VMT and vehicle trips. The estimates were made for the year 2010. A 2+ HOV requirement was assumed for trips ending in suburban areas and a 3+ vehicle occupancy requirement was used for trips ending in the downtown area.

- A few very preliminary results are available at this time. These should be viewed as very preliminary, however, as much more work is being done. Two measures of travel reduction have been examined to date; vehicle trips and vehicle miles of travel. The preliminary runs indicate that completion of the 250 miles of HOV lanes would result in a reduction of 3 percent in home-based-work vehicle trips and about a 6-percent reduction in VMT work travel. Considering all types of travel, the impact would be a ½-percent reduction in vehicle trips and 1½ percent in VMT. These numbers represent only the impact of in-vehicle automobile travel time savings and are currently being refined.

- In addition, work is underway to analyze the impacts on ridership levels on new and existing transit services. The work to date has just focused on carpool travel time savings and shifts to carpools. In addition, other TDM measures will be included and analyzed. These may include parking pricing and parking management, transit vouchers, and ridesharing programs. Parking pricing seems to be an important factor with HOV use.

- The issue of non-work travel is also very important and needs to be examined in greater detail. Most of the TCMs address the journey to work. This is understandable since the focus of recent transportation planning has been to satisfy peak-hour demands. The majority of travel is actually non-work in nature, however. According to the National Personal Transportation Survey work trips have declined from about 32 percent of all vehicle trips in 1969 to 26 percent in 1990.

- One of the reasons that the analysis of TCMs, including HOV facilities, shows a relatively small impact on vehicle travel and emissions is that the base it is compared against includes a large amount of non-work travel. In the Washington, D.C. area, the current modeling process estimates work trips accounting for about 25 percent of all trips. However, since work trips tend to be longer, work travel accounts for approximately 35 percent of all VMT.

- Using the WASHCOG 1980 home interview survey results, a closer look was taken at the nature of non-work travel. The first task examined the definition of home-based work travel. As currently defined, home-based work travel consists of trips between home and work with no intermediate stops. All other trips are classified as non-work travel. This definition does not really reflect travel today, where a work trip may include a stop at the day care facility. A better definition appears to be needed for work-related travel. This definition could include all work-related trips. Applying this definition to the same home interview survey results indicates that some 55 percent of the trips in the Washington, D.C. metropolitan area are work-related. True non-work travel accounts for about 45 percent, which is still a significant amount.

- Using a more appropriate definition for work trips would enhance the planning process. Further, it would ensure that TCMs are designed to address all types of work-related trips. There is still a good deal of work that needs to be done in this area, but using a better definition of work and non-work travel is a good start.

Analyzing Air Quality Impacts
Alice Lovegrove
Parsons Brinckerhoff Quade & Douglas

Ms. Lovegrove discussed the air quality impacts of HOV facilities. She reviewed the requirements of the 1990 Clear Air Act Amendments and presented an example of how the air quality impacts of HOV facilities are being examined with a project on the Long Island Expressway. Ms. Lovegrove covered the following points in her presentation.

- The 1990 Clean Air Act Amendments (CAAA) included guidelines for various project emission levels. These included the requirement that no transportation project could cause or contribute to any new violation of national ambient air quality standards, increase the frequency or severity of any existing violations, or delay timely attainment of the standards. All non-attainment areas must submit plans to the EPA outlining how they will reach the required attainment levels. The use of HOV facilities is one of the TCMs being considered in many areas.

- Two of the main features often associated with HOV facilities are reduced congestion and increased travel speed. These two features have great impacts on predicted air quality levels. Computer models are typically used to estimate and analyze the air quality impacts associated with different TCMs. Traffic volumes and emissions are two of the major inputs for these computer models. In general, there is a direct relationship between vehicle volumes and predicted carbon monoxide (CO) concentrations. A 10-percent reduction in volumes generally equates to a 10-percent reduction in pollutant concentrations in a free-flow situation.

- The emission estimates used in CO modeling are based principally on speeds. Other factors used in the modeling process are vehicle types, the proportion of cold and hot starts, and any inspection and maintenance programs in the area. As speed increases, CO emissions tend to decrease. Thus, the two major consequences of HOV use—decreased volumes and increased speeds—have beneficial effects on air quality.

- The Long Island Expressway is a major thoroughfare in New York State. The study area for this project covered approximately 40 miles of the facility. A total of 125 air quality receptor sites were identified along this segment. Two alternatives were examined in the study. The first, called G2, included the addition of one or two general-purpose lanes. The second alternative, called H1, focused on adding an HOV lane in each direction to the existing roadway.

- The air quality impacts of the alternatives were examined in two ways. The first examined the impact of the project on a regional scale and the second examined the impact on a local or microscale level. The Long Island Expressway analysis provides a good example of the air quality benefits of an HOV lane compared with the addition of more general-purpose lanes. On a regional level, the HOV alternative was predicted to result in lower emission burdens for all pollutant levels when compared to the no-build or G2 alternatives. On a microscale level, the benefits of the HOV lane alternative were even more pronounced. Only CO levels were examined at the local level.

- A number of general benefits related to HOV facilities can be identified. Analysis conducted on a proposed highway in Southern California helps illustrate the benefits—along with some of the problems—often encountered in the examination of air quality impacts. It was first analyzed as a traditional highway project with no HOV lanes. The focus of the air quality analysis was on the interchanges, since those are the locations where most businesses and other uses are located. In addition, air quality levels tend to be worse at interchanges due to vehicles queuing and lower operating speeds.

- Two different HOV volumes were modeled. A conservative case assumed 15 percent HOV use and a optimistic case assumed 30 percent HOV use. The modeling technique used to analyze HOV lanes involved separating HOVs from the mixed traffic on the facility and giving them higher operating speeds. The first alternative resulted in an 11-percent reduction in CO levels and the second showed a 24-percent reduction.

- A park-and-ride facility was then added to an interchange near one of the receptors. Park-and-ride lots are often sources of higher localized pollution levels due to the number of vehicles exiting the lots in a cold start mode. A cold start occurs when a vehicle engine has been off for more than about four hours. The addition of the park-and-ride lot in this example negated the air quality benefits of the HOV lane. Relocating the park-and-ride lot to a different part of the interchange resulted in an improvement in the air quality levels back to those estimated with the 30 percent HOV use.

- This final example indicates that a number of design factors and operating assumptions can influence the air quality modeling process. In addition to the location and size of park-and-ride lots and other supporting facilities, the analysis may be influenced by ramp locations, metering entrance ramps, and HOV bypass lanes at ramp meters.

Environmental Advantages of Commuting by Bus

T. David Smith
Environmental House Ltd.

Mr. Smith discussed the results of recent studies conducted for OC Transpo on the environmental advantages of commuting by bus. He also summarized the economic benefits of using the bus in the Ottawa area. Mr. Smith covered the following topics in his presentation.

- The central thesis in the analysis was that existing consumers are more likely to remain loyal and new consumers are more likely to purchase a service if the benefits of the service are substantial, user-specific, and unique. The environmental impacts of increasing automobile use are well known. According to the Canadian Department of the Environment, transportation accounts for one-third of all energy related emissions.

- A study was conducted for OC Transpo to examine the environmental and economic benefits of using the bus in Ottawa. Five communities located at different distances from the downtown area were identified. The energy consumption, CO_2 emissions, and NO_X emissions were calculated for bus and automobile alternatives from each of the five communities.

- The results of this analysis favored the bus alternative from each area. The bus option resulted in a 15- to 38-percent reduction in NO_X and other greenhouse gas emissions. The bus alternative also led to a drop in energy consumption by about 80 percent.

- The operating costs of using the bus and driving an automobile were calculated for each of the five communities. This identified the economic savings potential of the bus. Parking cost in the downtown area were examined and the monthly operating costs of driving were calculated. The costs of taking the bus were also examined. The cost savings of using the bus rather than driving ranged from $1,200 to $1,600 (Canadian) a year.

- Both the cost savings and environmental benefits of using the bus can be stressed in marketing programs. These benefits provide transit with a competitive marketing advantage over the automobile.

International Experience with HOV Facilities

Alan Gonseth, Champagne Associates — presiding

HOV Planning in Madrid

Julio Pozueta
Polytechnic University of Madrid

Mr. Pozueta provided an overview of HOV planning activities in the Madrid area. He also summarized the different elements of the transportation system and some of the current issues in the area. Mr. Pozueta covered the following topics in his presentation.

- The population of the Madrid metropolitan area is approximately 4½ million people. The transportation system serving the area is very complex. It includes an extensive roadway and freeway system, a subway, suburban rail service, and buses. Bus-only lanes are in operation on a number of arterial streets. The bus-only lanes were first implemented in the 1970s to provide buses with faster operating speeds in congested corridors. Contraflow, barrier-separated, and concurrent flow lanes are all used. The experience with these facilities has been very positive, but enforcement has been a problem in some areas.

- The Federal Ministry and the Regional Department of Transportation recently presented a new freeway plan for the Madrid metropolitan area. It includes the construction of several new HOV lanes to help reduce congestion in many corridors. The plan will be implemented through the development of detailed plans for each corridor. These plans will examine the most appropriate type of HOV facility for the specific corridor.

- Planning and design activities have been initiated in the National Highway 6 corridor. A 16-kilometer, two-lane, barrier-separated, reversible HOV facility is being considered in this corridor. The lanes would be located in the median of the freeway. This radial freeway is being widened to eight lanes. The corridor, which is located on the northwestern side of the city, includes rapidly growing suburban residential areas. Residents of the area tend to have high incomes and most drive alone to work in Madrid. Congestion is a problem in the corridor.

- It is anticipated that the HOV lanes will be open to buses and 3+ carpools. The lanes will also be connected to the radial street bus-only lanes in the downtown area and the downtown bus station. A travel time savings of 20 minutes is being projected for individuals using the facility in the year 2000.

- At this point, one concern is to help ensure that support is developed for the project among the different agencies and the public. Local enforcement groups have been involved in the planning, but enforcement plans need to be developed and implemented. Encouraging people to form carpools is also critical. A public marketing program is being developed, but a concern is that people who are accustomed to driving alone will not change to carpooling or taking the bus.

Contraflow Bus Lanes in Taipei, Taiwan

Jason Chang
National Taiwan University

Dr. Chang discussed the use of contraflow bus lanes in Taipei, Taiwan. He summarized the transportation system in the area and the evaluation program being used to determine the benefits of the contraflow bus lanes. Dr. Chang covered the following points in his presentation.

- Like many metropolitan areas around the world, Taipei is facing serious traffic congestion problems. A variety of approaches are being used to try to address these problems. A rapid transit system is under construction and is projected to open in 1994. Various TSM and TDM strategies continue to be considered and implemented.

- Since 1989, contraflow bus-only lanes have been implemented on two major arterial streets, Xin-Yi Road and Zen-Eye Road. These are parallel roads that connect the old downtown area to the newly developing residential and business area to the east. The Xin-Yi Road bus lane is approximately four kilometers in length and the Zen-Eye Road facility is about three kilometers long.

- The Xin-Yi Road facility is more heavily used. Approximately 16 bus routes operate on the lane, with some 80 to 100 buses using the lane during the peak hour. The Zen-Eye Road lane is used by 10 bus routes and averages 40 to 70 buses during the peak hour.

- At the present time no priority is provided at traffic signals for buses. A study is currently underway, however, examining the potential use of priority signal treatments for buses using the contraflow lanes. It is anticipated that this will increase operating speeds and improve on-time bus performance. Coordinating the bus lanes with other TSM and TDM strategies is also being examined.

- Analyses have been conducted to evaluate the cost and ridership impacts of the bus lanes. Preliminary results indicate that the facilities have resulted in bus operating cost savings and increases in ridership.

- Additional HOV lanes of all types are being considered for future application in the Taipei area. Expanding the arterial street bus-only lane network is being examined and the potential of implementing an HOV lane on a freeway is also being explored.

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